...RIAL BOOK
...AL LIBRARY
...OF MICH.

JULY 1938

ISIS

Quarterly Organ of the History of Science Society
the International Commission of the History of Science

FOUNDED AND EDITED BY

GEORGE SARTON, D. Sc.

Associate of the Carnegie Institution of Washington

(Harvard Library 18g, Cambridge 38, Mass., U.S.A.)

Managing Editor:

L. GUINET, 21, place Général Meiser, Brussels, Belgium.

Associate Editors:

C. H. HASKINS, Harvard University, Cambridge, Mass. (*Middle Ages*).
R. C. ARCHIBALD, Brown University, Providence, R. I. (*Mathematics*).
J. K. WRIGHT, American Geographical Soc., New York, N. Y. (*Geography*).
D. B. MACDONALD, Hartford Theological Seminary, Hartford, Conn. (*Religion*).
C. A. KOFOID, University of California, Berkeley, Calif. (*Biology*).
LYNN THORNDIKE, Columbia University, New York, N. Y. (*Magic*).
SOLOMON GANDZ, Yeshiva College, New York, N. Y. (*Science of Numbers*).
T. L. DAVIS, Mass. Institute of Technology, Cambridge, Mass. (*Chemistry*).
H. T. DAVIS, Indiana University, Bloomington, Ind. (*Philosophy of Science*).
A. POGO, Carnegie Institution, Cambridge, Mass. (*Astronomy*).
C. D. LEAKE, University of California, San Francisco, Calif. (*Medicine*).

Isis may be obtained from any Bookseller at the price of 6 dollars per volume. Illustrated. Members of the History of Science Society receive each year at least one volume of about 600 p. free of charge. Annual dues, 5 dollars. Corresponding Secretary, F. E. Brasch, Library of Congress, Washington, D. C., U. S. A. European Secretary, L. Guinet, 21, place Général Meiser, Brussels, Belgium.

THE SAINT CATHERINE PRESS LTD
31, rue de Tours, BRUGES (Belgium)

Printed in Belgium

ISIS

International Review devoted to the History
:: of Science and Civilization ::
Quarterly Organ of the History of Science Society and of the International Committee of the History of Science.

FOUNDED AND EDITED BY
GEORGE SARTON, D. Sc.
Associate of the Carnegie Institution of Washington
(Harvard Library 185, Cambridge 38, Mass., U. S.)

VOLUME XVIII

1932

THE SAINT CATHERINE PRESS LTD
51, rue du Tram, BRUGES (BELGIUM)

Printed in Belgium

Sarton
Taylor

ISIS

International Review devoted to the History
:: of Science and Civilization ::
Quarterly Organ of the History of Science Society and of the International Committee of the History of Science.

SUMMARY
of No. 52 (Vol. XVIII, 1)
(208 p., 2 pl., 1 facsimile, 2 fig.)

I. *Eighth annual report of the Corresponding Secretary and Treasurer of the History of Science Society for the year* 1931 . . . 5

II. *Main Articles* (12)

A. Pogo *(Cambridge, Mass.)*. — The astronomical inscriptions of the coffins of Heny (XIth dynasty?) (2 fig.) 7

J. C. Russell *(Chapel Hill, North Carolina)*. — Hereford and Arabic science in England about 1175-1200 14

M. C. Welborn *(Cambridge, Mass.)*. — The errors of the doctors according to Friar Roger Bacon of the Minor Order . . 26

L. Thorndike *(New York City)*. — Rufinus : A forgotten botanist of the thirteenth century 63

J. F. Fulton *(New Haven, Conn.)*. — Robert Boyle and his influence on thought in the seventeenth century. 77

D. Stimson *(Baltimore, Md.)*. — " Ballad of Gresham Colledge " 103

E. A. Guillemin *(Cambridge, Mass.)*. — Early developments in electromagnetic theory, with two unpublished letters by A. M. Ampère (1 facsimile) 118

H. W. Dickinson *(Purley, England)*. — J. O. Halliwell and the Historical Society of Science (London 1841). 127

N. E. Stevens *(Washington, D.C.)*. — The mycological work of H. W. Ravenel (portr.) 133

J. Ruska *(Berlin)*. — Heinrich Wieleitner (1874-1931) (portr.) 150
H. P. J. Renaud *(Rabat)*. — Additions et corrections à Suter « Die Mathematiker und Astronomen der Araber » . . . 166
G. Windred *(Bedford)*. — The relation between pure and applied electrical theory : with special reference to mathematical methods 184

III. *Notes and Correspondence* (6)

I. *Miscellanea*. — Guyton de Morveau (J. R. Partington). — Gunpowder (J. R. Partington) 191
II. *History of Science*. — California 192

Reviews (10)

Vth C. B.C. Szczygiel, P. P. — Das Buch Job, übersetzt und erklärt. Bonn, Hanstein, 1931 (S. Gandz) . . 193
XIVth C. Campbell, A. M. — The black death and men of learning. New York, Columbia University Press, 1931 (C. D. Leake) 195
XVIIth C. (Kepler, J.) — A tercentenary commemoration of his life and work. Baltimore, Williams & Wilkins, 1931 (N. T. Bobrovnikoff) 197
XXth C. Eckstein, G. — Noguchi. New York, Harper, 1931 (C. A. Kofoid) 200
Middle Ages. Wingate, S. D. — The mediaeval Latin versions of the Aristotelian scientific Corpus. London, The Courrier Press, 1931 (C. A. Kofoid) . . . 202
Millàs Vallicrosa, J. — Assaig d'historia de les idees físiques i matemàtiques a la Catalunya medieval. Vol. I. Barcelone, 1931 (L. Thorndike) 203
Philosophy of science. Davis, H. T. — Philosophy and modern science. Bloomington, The Principia Press, 1931 (C. J. Anger) 204
Biology. Almquist, E. — Grosse Biologen. Munich, Lehmann, 1931 (C. A. Kofoid) 206
Zoology. Wood, C. A. — An introduction to the literature of vertebrate zoology. Oxford, University Press, 1931 (C. A. Kofoid) 207
Superstition. Rudwin, M. — The devil in legend and literature. Chicago, Open Court Co., 1931 (L. Thorndike) 208

List of Plates (2)

1. H. W. Ravenel (1814-1887).
2. H. Wieleitner (1874-1931).

Eighth annual report of the Corresponding Secretary and Treasurer of the History of Science Society for the year 1931

MEMBERSHIP

Total membership, January 1, 1931	602
Resigned, canceled, death during 1931	50
	552
Total new members for 1931	42
Total membership, December 31, 1931	594
Members paying to Bruxelles office	96?
Members paying to Washington office	498
Dues paid for 1931	425
Deliquent	73

RECEIPTS

Total paid dues from 425 members	$2125.00
One fifth dues cash for Society	425.00
Four fifths dues cash for Isis	1700.00
Cash paid Dr. Sarton	1395.00
Balance paid December 31, 1931	305.00

EXPENDITURES		CASH RECEIVED	
Isis	$1700.00	From dues	$2125.00
Clerical aid	211.00	Book revol. fund	100.00
Printing	75.00	Royalty (Newton vol)	25.00
Kepler program	12.00	Transfer sale	
Reprints	12.62	*Isis*	10.00

A.C.L.S.	25.00	Sale partial set of *Isis*	65.00
Typewriter repair	3.00	Gift to Society	100.00
Telegrams and cables	11.39		
Postage and exchange	67.00	Total receipt	2425.00
Dr. Sohn	25.00	Total expend.	2424.49
Book fund admin.	75.00		
Resale set of *Isis*	9.38	Balance	$ .51
Refund exchange	6.00		
Photostat	1.20		
Mimeograph	4.90		
R.R. (Cleve., Balto & Phila.)	86.00		
Honorarium	100.00		
Total	$2424.49		

CARNEGIE CORPORATION OF NEW YORK REVOLVING BOOK FUND

(Received May 15, 1929 . . $7500.00)

Savings account May 15, 1929		$7000.00	
Interest to date		478.39	
		7478.39	
* Paid out		1350.94	
Total in savings account		6127.45	$6127.45
Checking account May 15, 1929		500.00	
Expense to Toronto, 1930	25.00		
Expense for Copernicus MSS.	25.00		
Expenses of administration	75.00	125.00	
		375.00	$ 375.00
			6502.45

F. E. Brasch
Treasurer.

* Paid to Columbia University Press	$ 500.00	
Paid to Clarendon Press	850.94	
Total	$ 1350.94	

The Astronomical Inscriptions on the Coffins of Ḥeny

(XIth dynasty?)

ABSTRACT

The fragments of the coffins of Ḥeny (XIth dynasty?) were discovered at Asyut in 1922 (see G. A. Wainwright and Battiscombe Gunn, *Annales du service des antiquités de l'Égypte*, 26, 160-71, 1926). These fragments confirm the hypothesis (see *Isis*, XIV, 306, 1930) that the astronomical ceiling decorations in the tombs originated as astronomical inscriptions on coffins. The essential features of both the northern and the southern panel are identified on the Ḥeny fragments. The orientation of the panels is discussed.

1. *The coffins of Ḥeny*

An account of the discovery of Ḥeny's burial was given by G. A. Wainwright (1); it was accompanied by Battiscombe Gunn's (2) description of the fragments of Ḥeny's coffins. " Some very perished pieces of boards from both an inner and an outer coffin " of Ḥeny " were found in the debris " (3), when a subsidiary burial in Ḥap-zefi's tomb at Asyut was discovered, in 1922. " It is, unfortunately, impossible to date Ḥeny's burial exactly, but everything points to its being of about the period of the XIth dynasty " (4). Thus, " the revered steward Ḥeny, justified " (5) was practically a contemporary of Msahiti, Mait, Khiti, Hounnou, Tefabi, and other Asyutians whose coffin lids

(1) G. A. Wainwright, A subsidiary burial in Ḥap-zefi's tomb at Assiut. *Annales du service des antiquités de l'Égypte*, 26, 160-66, 170-71, 1926.

(2) Battiscombe Gunn, The coffins of Ḥeny. *Ibid.*, 26, 166-71, 1926.

(3) Wainwright, *loc. cit.*, 161.

(4) Wainwright, *loc. cit.*, 166.

(5) Wainwright, *loc. cit.*, 161.

were decorated with the then fashionable calendars of the diagonal type (6).

It is a pity that of the astronomically important coffins of the revered steward ḤENY nothing but " loose planks and fragments " (7) were found, whereas the coffin (British Museum, No. 29,576) and the skeleton (No. 23,425) of another ḤENY of the XIth dynasty, found near Asyut, are in an excellent state of preservation. However, even loose planks and fragments are better than nothing in the case of a hitherto unique kind of astronomical inscriptions on coffins of the Middle Kingdom; it is to be regretted that no photographs of the ḤENY fragments are available (8).

If a calendar similar to the diagonal tables of the previously discovered coffins from Asyut ever decorated the coffins of ḤENY, it must have been inscribed on some of the missing boards; as such diagonal tables always appear on the inside of the lid, and as but one fragment (No. 1, discussed below) is described by BATTISCOMBE GUNN as part of a cover, the possibility remains that a diagonal table was part of the scheme of astronomical decorations of the coffins of ḤENY; fragments No. 9 which on " the inside bore traces of ink-writing and blue stars " (9) obviously belonged to some kind of astronomical inscriptions.

The importance of the coffins of ḤENY is due to fragments No. 1 and No. 4 described below. The identification, on these planks, of the essential features of the northern and southern panels confirms the hypothesis (10) that the astronomical ceiling decorations in the tombs of the Empire are a final step in the development which took place, during the Middle Kingdom, in astronomical inscriptions on coffins.

---

(6) See my papers, Calendars on coffin lids from Asyut (*Isis*, XVII, 6-24, 1932), and Der Kalender auf dem Sargdeckel des IDY in Tübingen (*Studien der Bibliothek Warburg*, 19. Heft, 1932).

(7) WAINWRIGHT, *loc. cit.*, 165.

(8) According to BATTISCOMBE GUNN's letter from Cairo, dated 14.7.31., the " ... fragments of ḤENY's coffin were in very poor state, and after being recorded were, as far as I remember, reburied. They were certainly never sent to the Museum. The notes published by me in the *Annales* form the only available record of these fragments..."

(9) BATTISCOMBE GUNN, *loc. cit.*, 170.

(10) See *Isis*, XIV, 306, 1930; for an independent confirmation, based on the Asyut calendars, see *Isis*, XVII, 19-22, 1932.

2. *Northern panel (fragment No. 1)*

" From a cover. Outside, a line of deeply-incised inscription... Inside, astronomical inscriptions and figures, of which a hand copy is reproduced in the accompanying plate. The stars were all blue, with red centres, and the | before the star in the names on the right was also blue; the other signs were in black ink " (11). Fig. 1 is a reproduction of a photostat copy of part of p. 171 of the *Annales*. The preserved edge of the board proves that we have the lower part of the panel before us; the mirror-image orientation of the northern panel of ḤENY is discussed in the last section of this paper. The inscription on fragment No. 1 consists of three parts : a group of seven divinities in the right corner, a sketch of the northern constellations in the center, and a group of an uncertain number of divinities—probably, nine,—in the left corner.

The names of the seven divinities in the right corner are those of the seven western discophores on the northern panel of SENMUT, or of the first seven among the eleven western discophores of SETI I and of the Ramesseum.

The three monuments of the XVIIIth and XIXth dynasties agree on the number of the eastern discophores at the opposite end of the northern panel—there ought to be nine of them. It is therefore reasonable to assume that the left side of Fig. 1 represents the beginning of a group of nine columns containing the names of the nine eastern discophores.

Let us now consider the central part of Fig. 1. The traditional representation of the northern constellations and of the associated divinities must have been so familiar to the draftsmen of the XIth dynasty and to their patrons that the decorator of ḤENY's coffins was quite satisfied with a mere sketch recording the figures and names—he left it to the imagination of the beholder to supply the familiar details of the mythological interpretation of the northern sky.

The two horizontal crocodiles, both properly labeled, precede the western group of seven discophores; the upper crocodile

(11) BATTISCOMBE GUNN, *loc. cit.*, 166.

is known to us in his later evolutionary stages—as a crocodile-tailed lion in the SENMUT-Ramesseum tradition, and completely lionized in the SETI tradition; on the ḤENY fragment we meet this leonine divinity for the first time in its purely reptilian disguise.

The title of Ān, identical with the Ramesseum title, proves that it was his business to fight as well as to keep things turning around the pole. It is probable that his image appeared above

FIG. 1

Lower part of northern panel, on the inside of the lid. Fragment No. 1 of the coffins of ḤENY. (From a photostat copy of BATTISCOMBE GUNN's sketch in *Annales du service des antiquités de l'Egypte*, 26, 171, 1926).

his name; it is not impossible that the hieroglyphic representation of the fighter is not by accident turned toward the lower crocodile. On the SENMUT ceiling the name Ān is attached to the Horus who is devoting his attention to the ovoid bull, while an anonymous man keeps the lower crocodile busy; in the SETI tradition we also have a split personality : the Horus Ān is turning the bull, while an anonymous man is teasing the lower crocodile. A glance at the northern sky—or at Fig. 4 in *Isis*, XIV, 309, 1930—will help to understand the duality of Ān; the stars α, λ, and κ Draconis can easily be interpreted as the hands and head of the anonymous man facing the lower crocodile (23 and o Ursae Maioris), although to the originators of the Egyptian starlore they represented the hands and the head of Horus Ān who devoted his undivided attention to the motion of Meskheti around the pole.

In spite of the deplorable state of preservation of the Meskheti region of the ḤENY fragment, and in spite of an apparently inconsistent use of bird-hieroglyphs, it is possible to assume that the name of Meskheti was mentioned twice on the northern panel of ḤENY : once under the main part of the figure, and again as the " end of Meskheti " near the point where he was attached. It should be kept in mind that the mirror orientation of the ḤENY panel implies that the bulky part of Meskheti was on the right. A special name like the " end of Meskheti " designating the stars ϵ, ζ, and η Ursae Maioris does not occur on hitherto known

northern panels. The ḤENY system of attaching Meskheti to the horizon is rather complicated. Are the six lines joining the pole with the horizon representing the rope (12) pulling the solar evening ship *mšḳt.t* during the six hours between sunset and midnight? In a correctly oriented representation, the oblique lines should join the pole with the western part of the northern horizon; after midnight, the subterranean sunship had to be

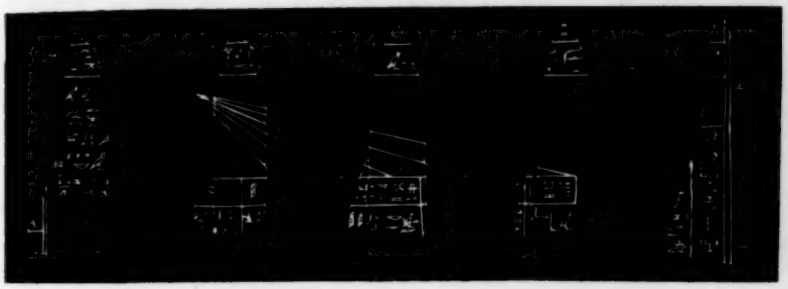


FIG. 2

Diagram of a sundial in the geographical papyrus from Tanis. About A.D. 100. (From a photostat negative of W. M. FLINDERS PETRIE's sketch in GRIFFITH-PETRIE, Two hieroglyphic papyri from Tanis, Plate XV, London, 1889).

pulled eastward by other means : a direct connection by cable with the pole was useless, hence the absence of the oblique lines on the other side of the midnight line through the pole. For the sake of comparison, I give, in Fig. 2, a reproduction of a sundial diagram from a Tanis papyrus (13) of about A.D. 100.

The hippopotamus goddess occupied her usual position at the head of the eastern group of discophores; her name must have been the same as on the SENMUT ceiling. If the analogy of the relative position of the figures and of the names of Meskheti and of Ān holds, the figures of the discophores appeared above their names at both ends of the panel; it is possible, however, that the missing parts of the lid were decorated in some other way, e.g., with simplified diagonal or primitive circular calendar tables; both the SENMUT and the SETI traditions prove that wide

(12) See K. SETHE, Altägyptische Vorstellungen vom Lauf der Sonne. *Sitzungsber. Akad. Berlin*, phil.-hist. Kl., 1928, XXII.

(13) F. LL. GRIFFITH and W. M. FLINDERS PETRIE. Two hieroglyphic papyri from Tanis. London, 1889. Plate XV.

open spaces cannot be avoided on the northern panel even if the circumpolar constellations and the two processions of discophores are displayed in all their splendor.

3. *Southern panel (fragment No. 4)*

" Part of the left side of a coffin; outside, incised and painted blue... Inside, traces of three registers divided up by vertical lines : in the uppermost, names of stars and constellations, of which... were visible; in the second register, illegible signs in red; in the lowest, varying numbers of stars in blue " (14). From this description it is clear that the mummy, facing the left side of the coffin, had before its eyes a southern panel similar to those known to us from the ceilings of tombs and temples of the Empire. The upper register contained, as in the case of the SENMUT ceiling, not only the names of stars and constellations, i.e., of the decans, but also the names of the associated divinities; thus, Duamutef and the Children of Horus appear along with Sirius and with parts (Kher-) of constellations; a planet (Jupiter or Saturn?) is also among them. The lower register corresponds, apparently, to the lower register of the southern panels of SENMUT and of SETI I.

4. *Orientation and position of the panels*

The identification, on the ḤENY fragments No. 1 and No. 4, of the essential features of a northern and of a southern panel, respectively, substitutes coffins of about the XIth dynasty for ceilings of the XVIIIth and XIXth dynasties as bearers of the oldest known astronomical charts and tables of this kind. In discussing the astronomically objectionable orientation of the southern panel of the SENMUT ceiling, I suggested that it might have originated on a vertical surface; the southern panel on the inside of the left side of the ḤENY coffin is the first known example of such a vertical southern panel. Another suggestion dealt with the original position of the northern panel; a mural dial would imply a vertical surface facing the southern panel; it

(14) BATTISCOMBE GUNN, *loc. cit.*, 169.

is possible that the mirror-image orientation of the northern panel on ḤENY's coffin lid is due to an attempt to shift the panel from its original position behind the back of the mummy to a new position above the mummy, as a kind of horizontal extension of the southern vertical panel of the left side.

An observer facing the northern sky has the eastern horizon to his right, and the western horizon to his left; a correctly oriented northern panel on the vertical inner surface of the right side of a coffin has, therefore, the group of eastern discophores at the head end, and the group of western discophores at the foot end. An attempt to keep the eastern discophores near the head of the mummy leads to a mirror-image orientation of the northern panel conceived as a horizontal extension of the vertical southern panel. This arrangement, apparently used on ḤENY's coffin, is not satisfactory : the top of the horizontal northern panel must meet the top of the vertical southern panel along the left upper edge of the coffin, in order to be readable to the mummy.

The ḤENY fragments bring us nearer to the solution of some of the problems connected with the astronomical panels on ceilings of the second half of the second millennium—such as the objectionable orientation of either the northern or of the southern panel, and the top-to-top (SETI type) or bottom-to-top (SENMUT type) juxtaposition of the panels.

189 *Harvard Library*, A. POGO.
Cambridge, Massachusetts.

Hereford and Arabic Science in England about 1175-1200

For a country located so far from the Mediterranean the share of England in the spread of Arabic science was rather astonishing. Professor HASKINS has shown the significance of that country in this movement by identifying the translations of a series of Englishmen who took part in it. (1) About most of these men little else was known. With such a small amount of personal information available it has been difficult to detect the institutional connections, if any, of these men or to place their work in the background of cathedral school or university development of the century. In the course of research primarily for biographical information about thirteenth century men of letters in England a number of items turned up about ROGER OF HEREFORD, DANIEL OF MERLAI, ALEXANDER NECKAM, and probably ALFREDUS ANGLICUS. They tend to show—I believe—that Hereford, possibly through a cathedral school, was a center of this learning in the second half of the twelfth century. (2)

" ROGER OF HEREFORD," says Professor HASKINS, " was a teacher and writer on astronomical and astrological subjects who was still a young man in 1176, and who, two years later, adapted astronomical tables of Arabic origin to the use of Hereford. (3)" Professor HASKINS also notes a number of items in contemporary

(1) *Studies in the History of Mediaeval Science* (Cambridge 1927), ch. II " Adelard of Bath," ch. VI " The Introduction of Arabic Science into England;" and to some extent chs. XV and XVIII.

(2) My interest in these men began in the fall of 1923 in a seminar in which Professor HASKINS took up certain questions raised in the above mentioned work. My research was as a fellow of the Guggenheim Foundation in 1930-31. I am glad to acknowledge the advice and suggestions of my colleague Professor L. C. MACKINNEY.

(3) *Op. cit.*, p. 126.

records which might refer to him : a Master ROGER OF HEREFORD attesting a York charter of 1154-1163, a ROGER OF HEREFORD witnessing a document of GILBERT FOLIOT of 1173-74, a ROGER vice-dean of Hereford owner of certain manuscripts, and a ROGER clerk of Hereford and itinerant justice. To these may be added a Master ROGER OF HEREFORD who attested a charter of Archbishop RICHARD OF CANTERBURY (1174-1184). (4) The frequency with which the title master is given makes one hesitate to accept any identification of the astronomer with a name not so prefixed. The chief difficulty seems to come from the popularity of the name ROGER AT HEREFORD.

The *Compotus* of 1176 has in the Digby MS. the title, " Prefatio magistri Rogeri Infantis in compotum." The gloss on a work of ALFREDUS ANGLICUS called him *Rogerus Puer*. (5) Since the preface itself states that the author was still young it was possible to conjecture that *Infans* or *Puer* was an inference from the preface. This puzzle is settled by the appearance in a Hereford charter of 1195 of a Master ROGER Infans as a witness. (6) The astronomer's name was probably the Anglo-Norman *Lenfant* or the English *Child*. This lead does not seem to carry one far. A WILLIAM CHILD, it is true, connected with Hereford, appears in the Pipe Roll for 21 HENRY II. (7) His son would be, of course, *filius Willelmi de Hereford*. In a Rawlinson cartulary there is a series of Hereford documents which mention a ROGER *filius Willelmi de Hereford* and several relatives including an uncle ROGER *filius Mauricii de Hereford*. (8) The latter is probably that canon of Hereford described by THOMAS DE MARLEBERGH as a great man whom the abbey of Evesham ejected from the position of Dean of Christianity for the churches of the Vale of Evesham about 1202. (9) The temptation to identify the astronomer as a member of this family is discouraged by the fact that the charters do not call any member of the family *Infans* nor master either.

---

(4) *Archeologia Cantiana*, V, 201-202.
(5) HASKINS, *op. cit.*, 125.
(6) Oxford, Balliol College, *MS* 271, fol. 60*r*.
(7) P. 70.
(8) Bodleian Library, *MS Rawlinson B* 329, fols. 123*r*-126*v*.
(9) W. D. MACRAY, ed. *Chronicon de Evesham* (London, 1863, Rolls Series), 196, 264.

The attestation of Master ROGER INFANS in 1195 prolongs his career nearly a score of years beyond the date of his treatise of 1178. If we may identify him with the Master ROGER who appears frequently in Hereford charters of the period, once as early as 1172, he may be assumed to have spent much of his time there. (10) The preface of his *Compotus* mentions that he had taught several years but does not give the place of his school. If his astronomical tables were written for school use the fact that they were prepared for the meridian of Hereford may be significant. Was there a school at Hereford? If so did it conform to the pattern of studies which ROGER OF HEREFORD inserts in the preface of the *Compotus?*

Before taking up these questions let us examine a treatise which seems to disclose the concluding chapter of the life of ROGER OF HEREFORD. This book has as an acrostic of the table of chapters which the preface says gives the name of compiler and corrector, ROGERUS COMPOTISTA ET REGINALDUS DE WALSINGHAM MONACHI SANCTI EDMUNDI RE-.IS. (11) In just such an acrostic was revealed the authorship of the *Compotus* of ROGER OF HEREFORD. The work is entitled *Expositiones Vocabulorum que sunt in Biblia* and has been assigned to a ROGER COMPOTISTA of the fourteenth century. Examination shows that it was probably earlier : the manuscripts themselves may be of the thirteenth century. The work is prefixed by a very remarkable index of the words commented upon. Arranged in approximately alphabetical order with reference to book and section number this index gives the impression that its author had a precise and orderly mind. But this might be expected of any computist. The heading of the Laudian manuscript to the introduction is " Prologus Promathei." This brings to mind at once the *Corrogationes Promethei* of ALEXANDER NECKAM whose interests were in many ways similar to those of ROGER OF HEREFORD. The *Corrogationes Promethei* have been explained by PAUL MEYER as the collections of one who was idle as Prometheus bound. (12)

(10) Balliol College, *MS* 271, fol. 16*r*, other instances on fols. 6*r*, 16*r*, 36*r*, 39*r*, 44*r*, 67*v* and 71*r*. He always appears after the canons of Hereford.

(11) Oxford, Bodleian Library, *MS Laud Misc.* 176, all 160 fols : *MS Bodley* 238, fols. 200*v*-262*r*; Magdalen College, *MS* 112.

(12) *Notices et extraits des MSS*, XXXV, 2, 649, 651-654.

It would be as appropriate for ROGER OF HEREFORD in a monastery after a busy life as it was for NECKAM in very similar circumstances.

The date of the work may be determined to a certain extent from the citations. The library at Bury was a large one : one might expect that up to date books would be there. The authorities are several. ALEXANDER NECKAM is cited very frequently. JOHN OF SALISBURY, among modern writers, is cited several times. (13) Others were PETRUS HELIAS (14), WYDO DE CREMA (15), HILDEBERT (16), PETRUS COMESTOR (17), and the *Architrenius* of JOHN OF HANVILLE (18). Two editions were apparently made. The Laud MS represents the first, and does not contain items which appear in the later and fuller edition. The latter, for instance, contain references to the *Physics* and *Nicomachean Ethics* which do not appear in the other. (19) NECKAM's *De Naturis Rerum* was written before the revision of ROGER's work. (20) It is difficult to determine whether the first edition was also written before this work. Of more importance is whether it was written before NECKAM's *Corrogationes Promethei*. In this respect however the evidence is clear. NECKAM's work preceded even ROGER's first version. (21)

Interesting as the information is that ROGER had before him the *Corrogationes* of NECKAM, a more important question is the extent of his borrowing. As samples let us take the books of Joshua and of Maccabees : both works are arranged according to the books of the Bible. In the former NECKAM comments upon about 15 words or phrases and ROGER upon 36. (22) Of these only 3 are identical. In Maccabees NECKAM comments upon 22 items and ROGER 87 : they have 23 in common, a much higher percentage. How much ROGER took from other writers

(13) *MS Bodley* 238, fols. 216*v*, 229*v*, 233*v*, 248*r*, 250*r*, 251*r*.
(14) *Ibid.*, fol. 213*v*.
(15) *Ibid.*, fol. 228*v*.
(16) *Ibid.*, fols. 232*v*, 236*r*.
(17) *Ibid.*, fol. 240*r*, 225*v*, 234*v*.
(18) *Ibid.*, fol. 214*r*.
(19) *Ibid.*, fols. 234*v* and 250*r*
(20) *Ibid.*, fol. 248*r*. Magister Alexander Nequam dicit in libro suo de natura rerum.
(21) *Ibid.*, fols. 121*r*, 121*v*, 133*v*, 243*v* : *MS Laud Misc.* 176, fols. 61*r*, 67*v*, 126*v*, 142*v*.
(22) For NECKAM's work I have used *MS Bodley* 550.

must await further investigation, but there seems reason to believe that some is original. In one important respect ROGER differed from NECKAM : the latter used the old arrangement of the Bible while ROGER already had the new, usually attributed to STEPHEN LANGTON.

In all of this there is no book which could not have been secured in the early years of the thirteenth century. There is nothing to prevent identification of this ROGER COMPOTISTA with ROGER OF HEREFORD. If the astronomer became a monk of St. Edmund's he probably died before 1214 : his name does not appear in the very long list of monks who took part in the election of that year. (23) His coauthor, REGINALD OF WALSINGHAM does not appear either. Among the miracles attributed to St. Edmund recorded by the contemporary abbot was one to ROGER DE HASELEYA, canon of Hereford, and his chaplain, ROGER DE AVESTANE. (24)

Another character of greater importance in the transmission of Arabic knowledge from Spain to northern Europe was ALFREDUS ANGLICUS or ALFRED OF ' SARECHEL'. (25) " We know from ROGER BACON and from internal evidence that he visited Spain." (26) He dedicated works to ROGER OF HEREFORD and to ALEXANDER NECKAM. Certain facts about the latter make it possible to give a conjectural date for the dedication. (27) The title of ALFRED's work reads, " Liber magistri Alvredi de Sareshel ad magistrum magnum Alexandrum Nequam de motu cordis." (28) This assumes that NECKAM was probably still a teacher and that he was not yet canon of Cirencester. In the latter capacity he appears as early as the spring of 1203. It assumes also that his interests were largely in science, although this is not so certain. NECKAM taught theology at Oxford for several years. Since theology usually was a man's ultimate interest the date of his interest in science should probably be pushed back. On the

(23) T. ARNOLD, ed. *Memorials of St. Edmund's Abbey* (London, 1896, Rolls Series, no. 90), II, 75-76.

(24) *Ibid.*, I, 207-208.

(25) HASKINS, *op. cit.*, 128.

(26) *Ibid.*, p. 129.

(27) For these facts see my " Alexander Neckam in England," *English Historical Review*. XVII (1932).

(28) C. BAEUMKER, *Des Alfred von Sareshel Schrift de motu cordis* (Münster, i.W 1923), 1.

other hand NECKAM was seeking a school as late as 1183 and would hardly have been called a magnum magistrum earlier. These indications point to the decade 1185-1195 as the most probable period for the dedication.

In the course of an examination of chartulary and printed documents for evidence of thirteenth century literary men I found that the name ALFRED was very uncommon. The following are the instances. A Master *Aldredus* appears at Hereford as a witness ca. 1153-55 and ca. 1175 according to the editor (29). A Master *Aldredus* was a chaplain of Dean GEOFFREY OF HEREFORD. (30) Three Hereford books once belonged to Master ALVEREDUS : the cathedral library, *MS* o.z. *IV :* Jesus College, Oxford, *MS* 26, and All Souls College, *MS* 82. His *obit* was on IX kal. January. (31) A Master ALFRED was canon of St. Peter of Exeter about 1205. (32) SENATUS BRAVONIUS of Worcester who died about 1207 dedicated a book to a Master ALFRED. These items may belong to the same career—that of the translator, ALFREDUS ANGLICUS. The dedication to ROGER OF HEREFORD whose connections as well as his name were—of Hereford—makes this highly probable.

Two such distinguished Arabists at Hereford would make this a scholarly center of some importance. Was there a school there ? In a poem addressed to GERALD OF WALES inviting him to come to Hereford SIMON DE FRESNE makes a rather clear statement that such existed (33) :

Flos et honor cleri, nostram te transfer ad urbem,
Sunt ubi philosophi, summus habendus ibi,
Urbs Herefordensis multum tibi competit, in qua
Proprius est trivii quadriviique locus,
Floruit et floret, in hac specialiter urbe
Artis septenae praedominatur honos.
Hunc, ubi tot radiant artes, de jure teneris,
Cum sis artis honos, artis amare locum.

(29) W. W. CAPES, ed. *Charters and Records of Hereford Cathedral* (Hereford, 1908), 17 and 27.

(30) Balliol College, *MS* 271, fol. 37*v*

(31) GOUGH, *The History and Antiquities of the City and Cathedral Church of Hereford*, etc. (London, 1717) (31).

(32) J. H. ROUND, ed. *Calendar of Documents preserved in France* etc. 918-1206. (London, 1899), 279 : Brit. Mus. *MS Cotton, Vitell. D.* IX, fol. 33*v*.

(33) J. E. MATZKE, ed. *Les Œuvres de Simund de Freine* (Paris, 1909), VII

The poem mentions the failure of GERALD OF WALES to receive high preferment. This may have occurred any time after 1176 but would be especially appropriate about 1200.

SIMON DU FRESNE, designated in the manuscripts of the poems, as canon of Hereford, was also the author of two Anglo-Norman poems, *Le Roman de Philosophie* and *La Vie de Saint Georges*. In both poems the author gives his name in an acrostic : it seems to have been a Hereford custom. He witnessed, ca. 1200 according to the editor, a convention between WILLIAM the treasurer and the chapter of Hereford. (34) He attested a charter of Bishop WILLIAM DE VERE (1189-1199) (35) and one of H, abbot of Salop. (36) By the time of THOMAS, abbot of Gloucester (1224-1228) he had died. (37) His obit was on 15 July. (38) SIMON's information about Hereford refers then to the time or slightly later than the time of ROGER and ALFRED.

Another Master SIMON at Hereford might be confused with SIMON DU FRESNE did not the two appear together in the same charter. (39) Unfortunately in a number of instances the mere citation Master SIMON does not indicate which one is meant. (40) This other Master SIMON is called Master SIMON MELUD or Melun or the Theologian. (41) Since the man's surname is known it seems probable that his other name *theologus* was given for achievement or occupation. He probably taught theology at Hereford.

Let us turn to the preface of ROGER's *compotus*. It reads as follows (42) :

Cum non sit humane benevolentie rem pluribus sed quod magis est, singulis necessariam infra terminos facilitatis includere, de compoto, quamvis difficillimum sit tante rei a viris summis sepe et diligenter tractate aliquid novi addere, sed et presumptuosum videatur juvenem

(34) CAPES, *op cit.*, 38
(35) Brit. Mus, *MS Arundel* 19, fol. 31*r*.
(36) Balliol College, *MS* 271, fol. 54*r-v*.
(37) *Ibid.*, fol. 70*v*.
(38) GOUGH, *op. cit.* (17).
(39) CAPES, *op. cit.*, 38.
(40) *Ibid.*, 19, 23, 24, 25, 37.
(41) GOUGH, *op. cit.* (6). Oxford, Balliol College, *MS* 271, fols. 52*r*, 61*r*.
(42) Bodleian Library, *MS Digby* 40, fol. 21*r*. Printed by T. WRIGHT, *Biographia Britannica Literaria* (London, 1846), II, 90-91.

tot senum scripta retractare, multorum tamen petitionibus quos ad hoc hujus scientie invitavit excellentia scribere compellor. Hoc namque, ut asserit Timeus Platonis, in beneficio oculorum seminarium totius extitit philosophie, que primo considerata mirabili motuum ac temporum variatione se erexit ad liberrimas humane nature excellentias, sermonem videlicet ac rationem exornandasi sermonem quidem recte loquendi vel scribendi ad intelligentiam (gloss, gramatica), argute vero disserendi ad fidem (gl. dialectica), ornate decorandi ad persuasionem (gl. retorica); sed et rationem ipsam, ut sicut cuncta numero (gl. arismetica), pondere (gl. musica), et mensura (gl. geometria) consistunt, ita horum trium scientiis ad rerum naturam investigandum et superiorum (gl. astronomia) et inferiorum (gl. phisica) pervexit. Necnon et ipsa theologia que est de creatoris cognitione, hanc sibi tanquam de eximia artium astronomia suam elegit portionem non solum sibi sed omni vite tam communi quam studiose maxime necessitatem. Hanc tamen tante excellentie scientiam astrologi, nature superiorum secreta motuumque tam celi quam stellarum certitudinem investigantes, compotumque ab illa certitudine multum discrepare reperientes, falsam ab omni philosophica disciplina abjiciendam arbitrantur.

The preface continues with a statement of the battles of the computists together with the author's statement that he has been kept busy for many years in the schools and by personal affairs.

The preface gives a rather interesting outline of study : the seven liberal arts, theology and the sciences, especially astronomy, astrology and physics. Of the seven liberal arts, grammar, logic, and rhetoric are regarded as only means to an end, the study of the subject matter itself, arithmetic, music, geometry, and astronomy. Even theology had much to learn from astrology and astronomy. How does this fit into what we know of Hereford? Simon du Fresne told us that the seven liberal arts flourished there. Simon the theologian was there. Roger of Hereford and Alfredus Anglicus, if we have identified him correctly, were eminent scientists. There is a striking similarity of interests. There is, moreover, in both the preface and in our knowledge of Hereford a notable absence of references to medicine and law and that in a century in which both were popular in the schools. Since Roger probably used the schools in which he taught as an illustration it seems very likely that we have here a picture of the interests of the school at Hereford—probably a cathedral school.

In the movement for the spread of Arabic science in England DANIEL OF MERLAI is a character of considerable interest. He gives some autobiographical information in his *Philosophia*. (43) He tried the University of Paris but was bored by the instruction and proceeded to Spain where he listened to the great translator GERARD OF CREMONA who died in 1187. His book was dedicated to JOHN, Bishop of Norwich (1175-1200). While these dates indicate the time of his activity others define it even more clearly.

In the Pipe Rolls of 1184-1187 there are references to a debt which he contracted along with three other men with a few, DEULEBENEIE. (44) How much earlier than 1184 was the date of the transaction is uncertain. He next appears in a Curia Regis Roll of 1198. (45) In the following year in the same suit he appears as parson of Flitcham, in which capacity he seems to have acted the year before. (46) For the Trinity term of 2 John (1200-1201) he appears in a Curia Regis Roll in regard to a question of land tenure at Cambridge. (47) The *Rotulus Cancellarii* shows him owing three marks *de Gernemue* also of Cambridge. (48) On 2 September, 1205 the bishop of Norwich confirmed to the church of Flitcham a small piece of land over which G. de Norfolk and the parson, Master *D. de Merleia* had had a suit. (49) As parson of Flitcham DANIEL OF MERLAI seems to have been succeeded by a JOHN OF MERLAI. It has been suggested that this JOHN was a son of DANIEL but of that there seems no evidence in the Holkham deeds. (50) Other items may belong

(43) For bibliography see HASKINS, *op. cit.*, p. 126-127.

(44) Pipe Rolls, 31-33 Henry II, see index : the same item is repeated for these years.

(45) P. 35.

(46) WALTER RYE, ed. *A Short Calendar of the Feet of Fines for Norfolk* (Norwich, 1885), p. 64

(47) P. 177. Cf. also WALTER RYE, *Pedes Finium* etc. *of Cambridge* (Cambridge, 1891, Cambridge Antiquarian Society), 4.

(48) P. 31.

(49) *Catalogue of Miscellaneous Deeds belonging to the Rt. Hon. the Earl of Leicester*, no. 703, at Holkham Hall, Norfolk. Used by courtesy of the Earl and with the assistance of the librarian, Mr. JAMES. The Flitcham deeds seem to have been misplaced.

(50) Hist. MSS Commission, *Report on Various Collections*, IV, 317. JOHN's name appears in the Holkham catalogue in nos. 704, 705, 706, 708, 713, 714, 715, 716, 717, 718, 719, 720, 722, 724, 728, 730, 731, 732, 737. JOHN's brother RICHARD occurs in most of those from no. 718.

to this man or to a later man of the same name : the donor of a gift to the priory of Castleacre, (51) and a debtor of 200 marks for disseisin in 1230. (52) In any case the student interested in Arabic science lived near the end of the twelfth century.

Now let us turn to a paragraph in the treatise of DANIEL OF MERLAI's *Philosophia* which has been the subject of much controversy.

> Vocatus vero tandem ab amicis, et invitatus ut ab Hispania redirem, cum pretiosa multitudine librorum, in Angliam veni. Cumque nuntiatum esset mihi quod in partibus illis discipline liberales silentium habet, et pro Tito et Seio penitus Aristoteles et Plato oblivioni darentur, vehementer indolui. Et ne ego solus inter Romanos Grecus remanerem, ubi huiusmodi studium florere didiceram iter arripui. Et in ipso itinere obviam habui dominum meum et patrem spiritualem, Johannem Norvicensem episcopum, qui me honorifice ut eum decebat, recipiens, valde meo gratulabatur adventui.

We may suspect that the friends of DANIEL were fellow students of his pre-Spanish days. Where? This would depend upon the subjects which DANIEL had studied. Obviously not theology or he would not have been so bored with Paris. Since he went on to Spain it seems probable that he was already interested in Arabic science. Was this study at Hereford? It is the one place where our present evidence points to a probable school. The reference to Roman law probably indicates Oxford. " In illis partibus " is broad enough to include Hereford if one is in Norfolk. Indeed, the use of the plural requires explanation if only Oxford was meant by DANIEL. One may conjecture that DANIEL had studied at Hereford before his departure for Spain sometime previous to 1187 and on his return before 1198 he found a great decline in interest in ARISTOTLE and others coming in by way of translations from the Arabic.

What were the antecedents of the interest in Arabic learning at Hereford? Professor HASKINS has pointed out a group of Lorrainers eminent in science who came to England in the second half of the eleventh century and the first half of the twelfth.

(51) Brit. Mus. *MS Harley* 2110, fol. 38*v* : FRANCIS BLOMEFIELD, *An Essay towards a Topographical History of the County of Norfolk*, VIII, 390, 465.

(52) P. 340.

Among the greatest were ROBERT DE LOSINGA, bishop of Hereford (53), and WALCHER, prior of Malvern, not so far from Hereford. It is perhaps significant that the two other great names of the scientific movement, ADELARD OF BATH and ROBERT OF CHESTER, indicate the rather sparsely settled western part of England. For the period even farther back Professor THOMPSON has written of " The introduction of Arabic science into Lorraine in the tenth century." (54)

As to the successor or successors of the school of Hereford we may well look to the Franciscan school at Oxford, whose interests have been so well described by Dr. LITTLE. (55) After mentioning the great stress upon study of the Bible and the languages, he quotes ROGER BACON for its interest in mathematics and physical science as follows :

" There have been found some famous men, such as Robert Bishop of Lincoln, and friar Adam Marsh and some others, who have known how by the power of mathematics to unfold the causes of all things and to give a sufficient explanation of human and divine phenomena; and the assurance of this fact is to be found in the writings of these great men, as, for instance, in their works on the impression (of the elements), on the rainbow and the comets, on the sphere, and on other questions appertaining both to theology and to natural philosophy."

All very much like the remark of Master ROGER INFANS. This Bishop ROBERT was a chaplain or one of the clerks of Bishop WILLIAM DE VERE of Hereford (1189-1199). His name occurs several times in the Balliol cartulary previously mentioned. (56) This confirms the statement of GERALD OF WALES to the effect that ROBERT GROSSETESTE was a member of the household of Bishop WILLIAM. GROSSETESTE was the first master of the Franciscan school at Oxford and set the stamp of his personality upon it.

If the school declined or interest in Arabic science lessened it was not because the pioneers in this science were subjected to ecclesiastical censure or restriction. NECKAM died abbot of

(53) HASKINS, *op. cit.* 333-335.
(54) *Isis* XII, 184-193 (1929).
(55) *Archivum Franciscanum Historicum* XIX, 810 (1926).
(56) *MS* 271, fols. 6*v*, 56*v*, 79*v*, 88*v*.

Cirencester. DANIEL OF MERLAI became a parson. ROGER OF HEREFORD probably ended his days as a monk of Bury St. Edmund. ALFREDUS ANGLICUS may have become canon of Exeter. All died in the good graces of the church. After all, it was Aristotelian metaphysics and its Arabic commentators rather than the other work of the Greeks which brought down the ecclesiastical prohibitions of 1210 and 1215. These pioneers do not seem much interested in theological discussion based on the new material.

Along several lines some advance in knowledge is made. The lives of ROGER OF HEREFORD and DANIEL OF MERLAI have been more precisely defined. ALFREDUS ANGLICUS has been identified with some probability as the Master ALFRED whose activity is evident about Hereford in the second half of the twelfth century. The presence of these men together with other evidence points to a cathedral school at Hereford at which the liberal arts, theology, and Arabic science were taught. Some surmises as to the antecedents and subsequent influence of the group are easy but conjectural. On the side of research the study suggests the possibility of supplementing by examination of unprinted records the careful study of translations and other treatises by such scholars as professor HASKINS.

University of North Carolina JOSIAH C. RUSSELL.

The errors of the doctors according to Friar Roger Bacon of the Minor Order [1]

1. The ordinary doctor knows nothing about simple drugs, but entrusts himself to ignorant apothecaries, concerning whom it is agreed by these doctors themselves that they have no other purpose but to deceive. The apothecaries cheat them in various ways. One is in the price of drugs, and as a result the patients are overcharged. Likewise in the quality of the drugs : first, because they give old drugs for new ones; second, one thing instead of another, for example an artificial bone instead of the bone of the stag's heart (2), and wood in which aloes is growing instead of pure lign-aloes, and so on indefinitely; third, drugs from which the virtue has been extracted by decoction instead of those which still contain their virtue, as for example boiled lign-aloes instead of crude, concerning which AVICENNA clearly says, « Take crude lign-aloes » (3), and rhubarb is boiled down in the same way and the virtue extracted, and so on; fourth, adulterated instead of pure drugs, as adulterated balsam, *tyriaca*, musk, viper's flesh, and many others.

2. Then in regard to compound drugs they are entirely wrong, and there are thirty-six great deficiencies, and branching off from these an infinite number of subsidiary ones, some of which are

(1) This translation has been made from the Latin edition of the De erroribus medicorum secundum Fratrem Roggerum Bacun de Ordine Minorum, prepared by A. G. LITTLE and E. WITHINGTON, in *De retardatione accidentium senectutis cum aliis opusculis de rebus medicinalibus*, 150-179, Oxford 1928. A translation by E. T. WITHINGTON of the first part of this work is in *Essays on the history of medicine*, edited by C. SINGER and H. E. SIGERIST, Zurich, 1924, p. 139-57, but BACON's interesting notes on drugs have been omitted; there are quite a few errors in translation, an inadequate system of reference to the works cited by BACON, and no critical footnotes.

The paragraph numbers have been added by the translator for convenience in indexing.

(2) For notes on the drugs mentioned by BACON see the *List of drugs* and the *Glossary of drugs* (*infra*).

(3) Crude lign-aloes is prescribed many times by AVICENNA (d. 1037); e.g., « Recipe galiae et xyloaloes crude, » *Liber canonis de medicinis cordialibus*, Liber III. XIII, V, 12, Venice 1582.

common to simple drugs as well as to compound ones. One error is that there is no health unless humor is purged; but among the ordinary Latin doctors no drug is found for purging any inflamed humor except red choler. Although HALY SUPER TEGNI (4) says there are nine kinds of black choler : and he says in another place in the same work that all of these humors when inflamed cause many illnesses, for instance there are anthrax, fistula, cancer, lupus, erysipelas, and other very serious illnesses of this kind, and many other common ailments against which the doctors do not have enough drugs, thus many are efficacious but only a few cure.

3. The second main deficiency is that different authors say that certain simple drugs purge contraries, i.e., opposite humors, for instance HALY (5) says that senna purges red choler, and AVICENNA in the chapter *On fumitory* (6), that it purges inflamed humors, and the Latins that it purges melancholy. In the same way the Latins say that rhubarb purges choler, but the Greeks and ARISTOTLE (7), that it purges phlegm, and so on in the same way concerning the other contrary statements on this subject; and this latter is held to be true by the great doctor, and I myself use it (rhubarb) against phlegm according to the words of ARISTOTLE, but I do not use the gross substance since I know that it is better to extract its virtue, which the Latin doctors do not know, arguing on their side that in tertian fever rhubarb is given against choler, and so the sick one is both purged and made well. To which I reply what JOHANNES DAMASCENUS (8)

(4) 'ALĪ IBN RIḌWĀN (d. 1061 or 1067) a famous doctor of Cairo. BACON calls him HALY SUPER TEGNI because his most popular work was a commentary on GALEN's *Ars parva*, called *Super Tegni* by the Latins. This work was translated by GERARD OF CREMONA. G. SARTON, *Introduction to the History of Science*, I, 729, Baltimore 1927. BACON's references are to Haly Rodoam, commentator, Galen, Microtegni, II, V, 26, and II, III, 1, in *Articella*, Venice, 1491.

(5) 'ALĪ IBN 'ABBĀS, (d. 994) born in Persia. His medical encyclopedia was called in Latin *Liber regius* or *regalis*, hence his Latin name *Haly Regalis*. G. SARTON. op. cit., I, 677. For BACON's reference see HALY ABBĀS, *Liber medicinae dictus regalis*, II, II, 54, Venice, 1492.

(6) AVICENNA, « De fumo terrae », *op. cit.*, Liber II, II, 27.

(7) R. STEELE, (editor) *Three prose versions of the Secreta Secretorum*, I, 70, London 1898.

(8) BACON is referring to SERAPION THE ELDER who lived in Damascus in the latter part of the ninth century. One of his medical compilations, the

says in his *Afforismus*, that any laxative drawing forth any other humor whatsoever also purges choler because the latter is not heavy and goes out easily. However, you should not consider this utterance as my opinion, but I only mention the contrary theories of the doctors concerning rhubarb in order that I may show you the failings of the doctors. Also you do not know how to extract the virtue from rhubarb, and therefore it is not necessary for you to be too much concerned in this part but to consider carefully what is useful. I desire now only to arouse, not to instruct you.

4. The third great deficiency is that when simple laxative drugs, in which there is something poisonous, are to be prepared by separating the poisonous from the useful, as for instance in the case of the serpent the venomous substance is separated from the flesh which cures all poison, the method of doing this is given much too briefly in the books of the Latins, and therefore many accidents are liable to occur. Thus in all kinds of rhubarb the useful part should be separated from the gross earthy material, and likewise in myrobalans and lign-aloes and in a great number of other drugs. But the doctors know nothing, that is the ordinary ones, except one in a thousand.

5. The fourth deficiency is that the relation between the quantity of noxious drugs and the human body is not known in this time, as for instance of scammony and opium and others of this kind, nor is the method of giving them known, nor in what quantities the men of this time should take them, nor the quantity which should be offered for each condition and age. Therefore death follows, or frequently a bodily insensibility, and various diseases, and through scammony a man may incur dysentery and death, and through opium, frenzy.

6. The fifth is that in regard to compound drugs they have no idea of the things which cancel each other, for example, if the beans of the *Malaca anacardium* are put in *tyriaca* they destroy

---

Practica, or *Therapeutice methodus*, or *Breviarium*, was translated into Latin by GERARD OF CREMONA, and is the book referred to by BACON. G. SARTON, *op. cit.*, I, 608. ForBACON's reference see, *Aphorismus* 82, « Quodvis medicamentum purgatorium necessario bilem flavam exagitat », IANI DAMASCENI, *Therapeuticae methodi*, Basle 1543.

the viper's flesh as AVICENNA (9) says; therefore a great many accidents occur through ignorance of this part of medicine.

7. The sixth is a result of the ignorance of the correct proportions of simple drugs in compound ones, and this is a most serious and terrible disaster. Because of this it should be *Maledicta* rather than *Benedicta* (10) which in the *Antidotarium* of the Latins is commonly said to purge phlegm; this is undoubtedly incorrect: because it is not able to purge phlegm to any great extent, although this book says so. For 1/3 diagredium purges more than 3/3 of the other substances for purging phlegm which are put with the diagredium in that *Benedicta:* whence that *Maledicta* purges choler and not phlegm, because scammony purges choler, which is too much in excess in the former, since it is put in in equal proportion with hermodactyls and the other drugs. And therefore the son of that ignorant Roman, who made the *Maledicta*, seeing his father's error, put in much of the drugs for purging phlegm, and called it *Benedicta transtiberina*, but this is not usually found in the books.

8. The seventh deficiency is in the fermentation of drugs, because as AVICENNA says (11), compound ones are not of any value without fermentation, and this fermentation takes place during an interval of time. But concerning this no definite theory has been evolved, except that an opiate drug should not be brought forth before the end of six months. There are certain ones which can be finished in less time, as may be found in SERAPION's (12) book. But time alone does not cause fermentation unless some other device is used along with it, because neither the narcotic in an opiate nor diagredium in a laxative is fermented with its simples unless it is reduced to one single substance. In order that this may be accomplished, three things are necessary: a certain amount of time, a well-mixed substance, and the dissolution of the poisonous material; and this is the secret of secrets of which all the common doctors are ignorant.

9. But it would take too long to go through all the other deficiencies up to the 36th, and longer still to follow out all their ramifica-

(9) AVICENNA, *op. cit.*, Liber V, preface, p. 972.
(10) See *Glossary of drugs*.
(11) AVICENNA, *op. cit.*, Liber V, preface, p. 972.
(12) IANI DAMASCENI, *op. cit.*, Liber VII, 6.

tions, nor am I able to do so; and therefore I shall pass on to the extrinsic deficiencies.

10. These, then, are the faults on the part of common knowledge itself and those on the part of the authors, who have not discussed these things clearly, and especially in the books which are written by the Latins. There is another deficiency concerning those things which the Latin doctors ought to use, because they do not have rhubarb senith, nor hepatic aloes, nor citrine aloes, nor birthwort, nor the flowers of the squinanth which alone among hot things repels, nor yellow oil of rocks, nor pure balsam, nor pure musk, nor pure lign-aloes, nor viper's flesh, nor oil of sesame, nor a great many other things which are of the greatest value in medicine.

11. But nevertheless there are other serious hindrances to the acquisition of knowledge on the part of ordinary persons. One is the ignorance of the languages in which medicine is discussed. For the authoritative works are full of Arabic, Greek, Chaldean, and Hebrew words, so that it is impossible for anyone to understand what the authors mean, as is shown in many places, and because they are ignorant of the Greek and Arabic and Hebrew languages from which an infinite number of words in the Latin books are taken, and because of their lack of knowledge they are not able to understand drugs nor how to make them.

12. Another deficiency is due to the ignorance of simple drugs because the doctors do not know them nor the prices of the things which they use, as was mentioned above incidentally, because it was one sign of their ignorance of drugs. Because old drugs instead of new ones, and one in place of another, and drugs from which the virtue has been extracted for those still containing their virtue, and adulterated for unadulterated things, are frequently accepted by the doctors, as I have already shown.

13. The third deficiency is that the ordinary doctor spends his time in discussing an infinite number of questions and in useless argumentation, and has no leisure for gaining the experience which he should have. Thirty years ago there was no time for anything but experience which alone taught them; but now by means of the *Topica* and the *Elenchi* they multiply an infinite number of incidental questions and dialectic arguments and countless sophistries, in which they are so completely buried

they are always seeking but never learn the truth. For learning comes by way of the senses (13) of memory and experience, and especially in the practical sciences, of which medicine is one.

14. The fourth deficiency is that they do not observe the heavenly bodies upon which every change of the lesser ones depends; laxative drugs and flebotomy and other evacuations and constrictions and the whole system of the medical art is affected by the atmospheric changes caused by the heavens and the stars. Therefore, the doctor who does not know how to observe the places of the planets and their appearances cannot accomplish anything in the practice of medicine, except by chance and good luck. This is discussed by the medical authors, namely HIPPOCRATES (14), GALEN, CONSTANTINE, RHAZES, HALY, and ISAAC (15) ; and is also clearly advised in very definite words by experienced doctors who know astronomy. It also is quite obviously taught by ARISTOTLE (16), PTOLEMY (17), and all excellent astronomers. However it would take too long to explain all of this. But the ordinary doctors of our time, seeking chiefly a most evil and disgraceful consolation for their ignorance, contradict these authors and the experienced doctors, and philosophers, and the senses, because a great many dangers crowd in upon reason in this matter.

15. The fifth deficiency is that they are ignorant of alchemy and agriculture (18); while on the contrary it is quite evident that practically all simple drugs are discussed in these two subjects. There are a great many difficulties which arise on account of the lack of knowledge of alchemy, because when the art of medicine teaches the use of the virtues of drugs without the substance, and it is necessary to do this in an infinite number of cases on account of the whole mass of poisonous earthy material, no distinction between them can be made except by means of alchemy which alone gives the method of extracting each virtue from

(13) Cf. ARISTOTLE, Metaphysica, Book I, chapter I, in *Works of Aristotle*, translated by J. A. SMITH and W. D. ROSS, vol. VIII, Oxford, 1908.

(14) HIPPOCRATES, De aere, aquis, et locis, in *Opera omnia*, I, chapters I and II. Naples 1757.

(15) ISAAC ISRAELI THE ELDER (d.c. 932). G. SARTON, *op. cit.*, I, 639.

(16) ARISTOTLE, *Secreta*, I, 64-65.

(17) PTOLEMY, (d.c. 161) *Quadripartitum*, four books on the influence of the stars.

(18) Agriculture here means botany.

any substance whatsoever; because it is necessary in working with drugs that there be resolutions and dissolutions of one thing from another which cannot be made without the aid of alchemy which gives the method of resolving any one substance from any other.

16. There are numerous examples of this : for instance, from the kinds of rhubarb used for purging phlegm the virtue alone should be taken and not the whole substance, of which fact practically the whole world of doctors is ignorant; although it is a most beneficial thing and especially good for the human body, and among all medicines it alone strengthens the natural heat and invigorates the body, just as is shown by ARISTOTLE in the *Secreta* (19), and I too have observed this in my own body. For every other drug weakens either a little or a great deal as everyone knows, and this alone strengthens. There is practically an infinite number of other similar examples (of drugs) from which the virtue should be extracted in order that they may be taken easily and without danger, as is shown in books dealing with drugs. But not only should the useful virtue be separated from the substance, but also the poisonous virtue from the useful substance, as for example in viper's flesh, in the head of the dragon, and in many others, it is necessary not only to extract the poisonous virtue but also other useless things, and not only this but it is also necessary to make a variety of resolutions of bodies from other bodies, as in the extraction of elements of various kinds, and various kinds of water and many other things, and whether those substances from which they are extracted are altogether useless, or poisonous, or indifferent, or useful for many other purposes. For thus by means of alchemy is extracted the blessed oil from bricks, rose water from roses, *et cetera* which can and should be much improved by alchemical methods rather than by the untutored. Again many drugs should be sublimated, just as AVICENNA (20) and others have clearly told us.

17. In addition to these and similar ways in which alchemy is useful in medical practice, the application of its methods is

(19) ARISTOTLE, *Secreta*, I, 70.

(20) AVICENNA, « De argento vivo. ... Sublimatum est stypticum... Argentum vivum sublimatus est interficiens propter vehementem incisionem, » *op. cit.*, Liber II, II, 46.

always valuable in medical theory and highly necessary, since it explains inclusively the entire development of things from their elements through the simple humors and then composite ones even up to the parts of animals and plants and men, as has already been touched upon; medicine does not explain this development but constantly sends the doctors to alchemy, as is shown by AVICENNA (21) in many places, and by other authors of medical works. Whence this alone of the sciences, that is alchemy, dares to explain what are the first four elements, then the second four, and a third four, up to twelve, from which man and the whole lower world are made. Whence there are twelve corporeal substances which have within themselves the power to determine the species of things and exist in the world *per se*, and the natural philosopher deals with only four of these elements. However the doctor, although he touches upon these things does not explain them but sends the medical students to alchemy, as is shown by AVICENNA in the first Canon (22), the one in which he disagrees with GALEN, who says that only blood flows through the parts of the body which need nourishment. For he shows that the other humors are necessary for many reasons, and after putting forth his arguments, he confirms what he has said by means of alchemical experiments, saying, « We also find blood mixed with other humors which are distinct from it. When moreover it is extracted and by degrees is put into an *atuum* or an *egem*, which are vessels used in distillation in alchemical experiments, by observation it may be seen that it is separated into a part which is like froth and is red choler, and a part which is like dregs and is thick and melancholic, and a part which is like the whites of eggs and is phlegm, and a moist part which is the watery substance whose superfluity is evacuated in urine, (23) » and in the following chapter he says, « That if all these things are

(21) Especially in the prefaces to Libri II, and V.

(22) Although AVICENNA does not always agree with GALEN in this chapter, BACON is not correct in implying that he disagrees with GALEN in this particular passage, « Inquit Galen ille, qui dixit, quod humor naturalis solummodo est sanguis : et alii humores sunt superfluitates, quibus non egetur, non dixit verum, » *op. cit.*, Liber I, I, IV, 1.

(23) This is a direct quotation from AVICENNA, *op. cit.*, Liber I, I, IV, 1, lines 7-11.

compared, that which is quite warm is blood. (24) » And these humors are in the first place four simple ones each of which is composed of four elements but one element predominates; and then there are four composite humors, each consisting of four simple humors, but from one of them on account of its predominance, as in a choleric man or a choleric member, there comes a composite humor which is called choler, and yet is composed of all the simple ones but called by the name of the controlling humor; and also from the bloody man or member, comes the blood made up of all humors, but it takes its name from the one which is superabundant, and so on concerning the others.

18. Therefore for this reason and for countless others, alchemy is necessary in speculative medicine in order to become acquainted with the generation of things and with the properties of natures. When AVICENNA in his second Canon argues against GALEN concerning the generation of quick-silver he says, « GALEN thinks that quick-silver is made only from cinnabar in a vase smeared with clay, above which a fire is burned and thus it is sublimated (25) » but this is not true; on the contrary cinnabar is made from quick-silver with sulphur, and then it is possible to extract it from quick-silver just as it is extracted from mineral cinnabar. And thus I have treated of the science of alchemy, according to the words of AVICENNA in his letter to HASEN concerning the value of alchemy, in which is shown the generation of cinnabar from quick-silver and sulphur. But it would take too long to enumerate the uses of alchemy in its relation to both theoretical and practical medicine; therefore let this be enough for the present.

19. The final condition which shows the lack of knowledge on the part of the ordinary doctors, is their ignorance of natural philosophy. For ARISTOTLE says that where natural philosophy ends, there medicine begins, and natural philosophy will give the first principles of health and sickness, as he says (26). That

(24) Here again BACON quotes exactly from chapter II of Liber I, I, IV « Quod autem de hoc toto res colata est, quae est bene cocta, est sanguis, » a line which in turn is a quotation from Galen, Liber IV, c. 5.

(25) AVICENNA, *op. cit.*, Liber II, II, 46.

(26) ARISTOTLE, De sensu et sensibili, I, in Parva naturalia, Part I, in *Works of Aristotle* vol. III[2] translated by J. I. BEARE, Oxford 1908.

natural philosophy is unknown not only to the Latin doctors but also to all ordinary philosophers, can easily be shown; and likewise with this in the same way can be shown their ignorance of metaphysics, although all mediocre modern students brag about their knowledge of these two sciences : and because this is stated principally with respect to the philosophical errors which abound in theology, I therefore wish to determine this point more clearly. Just like the bachelors and masters of arts in this period are the theologians, and on account of the ignorance of these two sciences the whole study of theology is being destroyed in its foundation, and in the same way, the study of medicine : since the theologians are much too eager to introduce these two sciences, as will be touched upon below, and likewise the doctors seize and steal whatever they can understand concerning natural philosophy. But in these days it is impossible for natural philosophy and metaphysics to be understood; a sufficient proof of this is that there is no agreement in anything. According to ARISTOTLE in the *Metaphysica* (27), this is an absolute sign of ignorance.

20. But there are many reasons for this. One is that the ordinary students of these subjects have nothing to use except the books of ARISTOTLE which they cannot understand, mainly because of their strangeness. For these sciences have been generally taught for only about twenty years, and textbooks have not yet been compiled. For although logic has now been in use for 300 or 400 years or more, up to now it has not been understood because one writer never agrees with another in even the most worthless sophism. But I do not wish to linger over the ignorance of logic, since it will be proved below that nothing worthwhile is known concerning it.

21. In the second place natural philosophy is unknown on account of the incongruities in translation : if one person says that ARISTOTLE meant a certain thing, another says that he meant the opposite, as is known to everyone. Third, because of the imperfection of the translation which is used, since an infinite number of lines are left out as is shown by the Greek original, and even whole chapters and many books; so that only about half of the books dealing with these two sciences written by

(27) ARISTOTLE, Metaphysica, Book III, chapter III, in *op. cit.*

ARISTOTLE have been translated into Latin. Because ARISTOTLE wrote fifty books concerning animals, as PLINY says (28), and I have seen in Greek those which are not in Latin; we have not more than nineteen books. Practically all of the books concerning plants are lacking, especially in a translation which is readable, as is clearly shown in the translation by MICHAEL SCOT (29), but beyond that we have very little. The book concerning inanimate objects is entirely lacking, because the few chapters which are added at the end of the *Metheora* are not from the text of ARISTOTLE, as is known from another translation.

22. Because although in the book which is called *Lumen luminum* (30), which many ascribe to ARISTOTLE, there are said to be twelve corporeal substances for the natural generation of various species, that is four elements and eight others, this cannot be learned in ordinary philosophy, neither do the doctors explain it nor can anything be determined concerning them from their own nature : and therefore AVICENNA in his chapter *On humors* (31) refers the doctor to the methods of alchemy in his argument against the theory of GALEN that the blood alone nourishes the body; and elsewhere in the same chapter and in the following one, and in many places he touches upon these things which are based upon this sentence which is found in *Lumen luminum*. Therefore it is necessary that only by means of universals is known the first cause of the generation of the nature of things in most books, and not by particulars, nor with any certainty because this latter is more by means of experimentation than by argumentation. For ordinary natural philosophy deals with everything by means of universals, and by means of narration in many things, and argumentation in others. But it does not treat of the particular, it does not advance by means of experimentation on account of which it does not give proofs; but specu-

(28) PLINY, *Historia naturalis*, VIII, 16, Venice 1476.

(29) From many passages in his works we know that ARISTOTLE intended to write a separate treatise on plants, and it is probable that he wrote one. But there is only a small work ascribed to him by some, but usually classed as spurious. However there are many passages on plants in his other writings. T. E. LONES, *Aristotle's Researches in Natural Science*, 95-101, London 1912.

(30) As this was a title given to several alchemical treatises it is not certain which one was referred to by BACON.

(31) AVICENNA, *op. cit.*, Liber I, I, IV, 1.

lative alchemy determines by means of particulars all the primordial generation of things from elements, humors, and other things, as has been said. Then by means of particulars are found all the kinds of inanimate bodies even including the composition of the parts of plants and animals. For practical alchemy releases the secret of secrets concerning the parts of plants and animals, which ARISTOTLE (32) explained to ALEXANDER, by which it is possible for base metals to be changed into more valuable ones, and for greater things than this to be done. Philosophical agriculture also shows by means of particulars and by experimentation, the generation of plants and animals from first principles, and according to the whole but not according to the parts. But these two sciences are not used by the ordinary students, although many books concerning each are possessed by the Latins : and so there is a great deficiency in Latin learning, and many useful things in that field are neglected.

23. But although many things are certain about medicine, yet among the Latins there are many defects in this respect; nor is it to be wondered at since it is hazardous to experiment on the human body, also extremely difficult, and therefore it is harder to work in this science than in any other. Therefore excuses should always be made for doctors even though they must make many mistakes. For creative and experimental sciences whose experiments are made on inanimate objects can be retested many times until all the faults and errors are cast out. But the doctors are not able to do this because of the superiority of the material on which they are experimenting; because that body requires that no mistake be made in experimenting upon it, and so it is difficult to experiment in medicine. But one cannot arrive at the truth except by means of experimentation, therefore the doctors are excused when they make mistakes, more than other experimental scientists.

24. The indications of their faults are of the following nature, namely, there are disagreements among the doctors concerning the methods of healing, and also stupors and deaths often occur in their practice. Likewise the ordinary people who do not use drugs are stronger, better looking, and have a longer life, or

(32) ARISTOTLE, *Secreta*, I, 88-91.

greater longevity, than those who are addicted to the use of medicine; this is especially evident in the northern countries where the use of drugs is rare and infrequent. Therefore they are handsomer, stronger, and have better bodies and spirits than the other peoples who use a great deal of medicine, and they live longer : the exact opposite of this would necessarily be true if the use of drugs were perfectly understood by the doctors, and if all drugs and likewise all artificial compounds were prepared in the right way and given to each person in proportion to his age and physical constitution, and the horoscope of each, which changes the entire bodies of all men and all things every hour; and according to other special conditions which are known to each intelligent doctor, and also if they were given where necessary, and not elsewhere and if the appropriate drug and no other were given, i.e. not one drawing forth one humor instead of another, but the humor which is superfluous and is causing the illness : of necessity the contrary would be true, namely, that the use of medicine would bring about a longer life, a stronger, more animated and handsomer person than if medicine were not used. These therefore are the faults of the doctors.

25. The causes of these defects and their ramifications are numerous, and I shall discuss those which are well known to each doctor after he has had experience in the practice of medicine. First, the Latins do not have a sufficient number of diagnoses of diseases; because only AVICENNA (33) gives diagnoses, and, to some extent, RHAZES in his *Divisiones* (34). But these diagnoses are not sufficient, as is clear to everyone, and AVICENNA, as the translator of his book says, was a philosopher and not a doctor, and at the end of his translation he deplored the work he has done on it, especially since he found the books of RHAZES and others filled with practical as well as theoretical medicine. Hence the Arabs have not used to any great extent the works of AVICENNA, but have used those of other writers, and the Latins who practice according to his book often make mistakes, as experienced people know. Therefore RHAZES put the diagnoses of diseases among

(33) AVICENNA, *op. cit.*, Libri III and IV.

(34) AL-RĀZĪ, (d. 923-24). *Continens*, in *A treatise on the smallpox and measles*, translated by W. A. GREENHILL, London 1848.

the first duties in the practice of medicine, so that the causes and symptoms of any kind of illness might be clearly recognized, for example in the symptoms of quartan and of dissentary, and of others, because one symptom comes from one cause and has its own definite characteristics and its own cure. This is the first and principal source of trouble, but this is not made evident in the Latin books.

26. The second source of trouble is that when they have reached the question of the cure, assuming that they know what are the diagnosis of the disease and the causes and the symptoms, the Latins lack many drugs, both simple and compound, or they have received from other countries adulterated ones, or they are not in use among the Latins although they have them. For example, there is rhubarb senith, which is Indian rhubarb, and is far better than Pontic rhubarb and *reu barbarum*, which is not found at all among the Latin apothecaries, although it is most useful to the human body; in this is ARISTOTLE's secret concerning the conservation of the health of ALEXANDER, because it is the life of the liver, as ARISTOTLE said (35), and it strengthens the natural heat which is not done by any drug except this. Thus it strengthens the body and fortifies it against the effects of other medicines, and this has been learned by experience, if it is correctly prepared and taken in the correct way, in which lies the great secret. And so on concerning innumerable others both simple and compound.

27. Viper's flesh, although it is one of the important medicines, as ARISTOTLE said (36) and as the experienced doctors know, is not in use among the Latins, nor is it easy to obtain it in a pure state. Because it can be adulterated in many ways, and it may be made from other serpents, and many imported drugs are adulterated and it is only by a few kings that pure drugs can be found in the necessary quantity, such as musk, balsam, and others of this nature. Lign-aloes is adulterated and boiled and the virtue taken out, and the wood which contains hardly any virtue is sent to the Latins, and also Pontic rhubarb and *reu barbarum* and many others. And the most renowned one

(35) ARISTOTLE, *Secreta*, I, 81.
(36) *Idem*.

which ARISTOTLE praised above all other compound medicines is not to be found by any method, nor the eight drugs which are required for it, as it is given in the *De regimine vite;* and so on time after time concerning the other compound medicines.

28. And the third hindrance, supposing that they can obtain drugs of this kind from the regular apothecaries, is that the ordinary doctors are not able to do anything but trust them. And therefore the apothecaries give them old things for new, spoiled instead of good things, for example, some other bone instead of the bone of a stag's heart, and thus in a great many ways are the doctors cheated, not only in the quality of drugs but also in the price, as was said above. This is what makes things especially difficult for them; nor is there any remedy for this, unless one is powerful and wealthy and can supply and prepare everything himself or with the help of the people in his own home.

29. The fourth hindrance, supposing all the other difficulties to have been set aside, is that up to this time the medical authors have not given the remedies for many illnesses in the books of the Latins : for example, HALY SUPER TEGNI (37) says : Humors whenever they are inflamed and changed into a black choler, are of the yellow variety of choler and the phlegm is salt and the humor melancholic and bloody; therefore there are nine kinds of black choler, six inflamed ones for each of the yellow kind, and one of the salt phlegm. Also there are many kinds, pure and impure, the pure is a nourishing medicine for the body, the impure is that which is poured into the veins : and it is said in the first place in that same book, that there is produced from each one of these humors whenever it is inflamed, many illnesses, for example, anthrax, carbuncles, lupus, quartan, and many others, for which the symptoms are not given by the authors, just as in many other cases. But the authors of the Latin books have only a very few drugs which have been tested and proved, and almost none at all which cure. Although many are beneficial, very few or none at all cure these serious illnesses, as is shown by the prevalence of these maladies throughout the whole world.

30. The fifth deficiency is that it has not been shown by the authors of the Latin books concerning the known drugs and

(37) 'ALI IBN RIḌWĀN, *Super Tegni*, II, V, 26.

those which are used daily, which humor they purge, as has already been said. For example, HALY (38) says that senna purges red choler; AVICENNA, in the chapter *On fumitory*, that it purges inflamed humors; the Latin teachers, that it purges melancholy. In the same way there are differences of opinion concerning rhubarb. ARISTOTLE (39) says that it purges phlegm, and so do the Greeks. No medical author says in the Latin books what humor it purges. But the theory of the Latin doctors is that it is choler, and so on concerning many others. And therefore great danger arises.

31. The sixth difficulty is in the preparation of simple drugs. Because it is necessary that many be prepared by alchemical methods, for instance, many oils and health-giving waters, and many other beneficial things, by means of distillation. And if they are prepared by the correct methods of alchemy, they will be of far greater virtue. Second, it is necessary because in many cases the virtue must be extracted from the gross earthy substance, which is very poisonous to the body, as for instance, in the case of *reu barbarum*, and myrobalans, and lign-aloes, and many others, in which a part of the extracted virtue cures efficaciously and successfully, and without harm, as experience shows. Third, it is necessary because some are poisonous, such as mercury and many others, so that they require correction by means of sublimation and other processes, in order that their harmfulness may be lessened to some extent. In the fourth place it is necessary because what is taken in the greatest drugs, that is precious stones, gold, and silver, which ordinarily when given in medicine, pass through the body and do not linger, and because of this there is little or no value in them, although they are taken in large quantity, because they can neither be assimilated nor dissolved, while they remain in their gross and hard substance before calcination or dissolution in water; and therefore they pass through. But if they are prepared by the secret method of alchemy, that is, if they are calcinated and dissolved in water, so that they are well prepared, especially with the aid of experimental science, they can even in small quantities aid the human body, beyond

(38) 'ALI IBN 'ABBĀS, *Liber regalis*.
(39) ARISTOTLE, *Secreta*, I, 70.

all expectation. In the fifth place, by the same means, with the aid of another science, many substances are reduced to primary matter, concerning which ARISTOTLE speaks in the eighth book of the *Metaphysica*, and as is written at the end of the *Metheora*, they will be able to cure the human body more than is believable. But these things are hidden because the said science, or the said sciences, are not used by the doctors. In the sixth place, this science is needed in order to make many medicines, not only for preparing them, according to what GALEN teaches in the *Dinamidiarum* concerning the composition of calcined copper and AVICENNA contradicts him concerning the composition of minium (40), and PLATEARIUS (41) shows how to make certain things, and also many other authors in whose writings are shown the practice of this science.

32. And if we run through the list of compound medicines we shall find greater difficulties. For there is an almost infinite number of drugs which cannot be mixed together so that one drug may be made, and one compound. For only opposites have a common medium, although this is doubtful, because then each of the opposites has only two extremes, as ARISTOTLE says and demonstrates in the fourth book of the *Metheora* (42): three or four or more do not make a mixture, as anyone may easily argue. And yet ARISTOTLE says in the same book that only opposites have a medium, and every medium is made up of opposites, and thus it is not easy to know the truth in this case. Besides, one opposite which is superior often destroys the others, nor does it submit to the mixture, and so there is a great loss in the combination of drugs, especially since the authors do not solve this difficult question, and those who make these things have no skill in this art.

33. In the second place there are three difficulties in regard to proportions. One is in the proportion of a base and the other

(40) AVICENNA, *op. cit.*, « De syrengi, i. Cinnabari. Syrengi quid est: Est proximus virtuti asedinegi, immo est fortior. » *Syrengi* is minium. Cf. GALEN Liber IX, 59 f.

(41) JOANNES PLATEARIUS THE YOUNGER, a physician living in Salerno in the latter part of the eleventh century. His Compendium was called *Practica brevis*. G. SARTON, *op. cit.*, I, 770.

(42) BACON is incorrect in this quotation. He was probably referring to the *Metaphysica* IX, chapter VII.

things which are put with it, so that the correct proportion of each may be known in every medicine; and this is a very difficult question and one which is unknown to the ordinary doctors. The second difficulty is to secure from the mixture the degree of heat and other qualities which you desire, just as in simple medicines, and this cannot be determined except by the method which ALKINDI (43) teaches concerning degrees, a method which is very difficult and completely unknown at this time to the Latin doctors, as every one knows. For whoever wishes to perfect the science of the philosopher mentioned above, must know well the general principles of mathematics on account of the nature of the greater and lesser inequalities, and on account of the nature of the proportions, and on account of the very difficult laws concerning fractions, which were used by the author mentioned above. The third difficulty is that, even if in the two above mentioned cases, no defects exist, there is a third one at hand. Because the arrangement of the heavens is changed about every one hundred years, and therefore all things born on the earth change their complexions, and human bodies also (44); and therefore the same proportions of drugs should not always be continued as they were given in the books of an earlier period, but definite calculations are required according to the lapse of time. But who is able to know the degrees of each change? Certainly not a mere physician, nor even one learned in astronomy, unless his knowledge be perfect.

34. Besides, fermentation is required in compound medicine, because compound medicines will be of no value without it, as AVICENNA says. For compound medicines must be made according to their own natures and not according to the nature of simple ones; and because of this a long process is required for them, in order that they can remain in the one virtue which comes as a consequence of all the others, but this period of time for medicines has not been determined among the Latin authors. Because some take several days, others several months, some one month and some one day, and whatever may be the number

(43) AL-KINDI (d.c. 873). The work referred to here is quite evidently the *De medicinarum compositarum gradibus investigandis libellus*. Cf. G. SARTON, *op. cit.*, I, 559.

(44) Cf. AVICENNA, *op. cit.*, Liber I, I, III.

of days or months is varied in many ways, nor can this be determined except by long practice; and because this fermentation is necessary, therefore when it is not used in each medicine according to its own nature, there is great loss.

35. Besides all of these there is another principle source of trouble which does more harm than any other, and more than many others together, and this is that signs of the times are not observed, as was mentioned above. Each hour has its own nature, and each quarter of a day, and each day, and so on : and not only do they have natural and common natures, which occur continuously on account of the motion of the sun and moon and fixed stars which move around above the zenith of the head; but also they have natures which change according to the movement of the other planets and according to the variety of the conjunctions and appearances. And not only do the seasons have this but also humors and the complexions of nature and all things which are born and decay, and therefore it is necessary that the doctors know how to take into consideration these changes in the body upon which they are working, and in the things which they are using. Otherwise they will make mistakes in all their work.

36. This therefore is the reason for these statements; but experience proves the same thing, and moreover all the medical authorities have found this to be true, as was noted above, and all the learned astrologers such as ARISTOTLE, PTOLEMY and others; and the doctors who are skilled in astronomy most certainly know this, and even the ordinary doctors use this in their practice and in all things in which it is possible, they observe the sun and moon and the changes of things caused by them, although they have no scientific knowledge concerning these things, but it is evident that each one does these things for himself, according to custom and use. But if any author says a doctor, inasmuch as he is a doctor, should not prove these things, as AVICENNA and HALY (45) have said in a certain place : first it is that they themselves should not contradict them, when in some other place they may be willing that the doctors should make use of

(45) AVICENNA, *op. cit.*, Liber I, II, III, 3, « De naturis temporum ». HALY, *op. cit.*, I, I, 2.

the contemplation of the heavens. And therefore they wish that the doctor, inasmuch as he is a doctor, neither can, nor should, have to take these things into consideration: but still it is necessary that they should do this by means of the study of other sciences, because their labors are based not only on a knowledge of medicine but on many other sciences, and especially on three, of which one is alchemy; second, of more importance, astronomy; and third, most important of all, the one concerning which we shall speak later.

37. But these difficulties in the practice of medicine are not the only ones, but others arise on account of the lack of languages, a subject which has already been discussed. Although this is universal among the Latins, it is especially true in the medical practice, because of the many words of other languages which are retained in the latter, and because of the hindrances of this speculation concerning which I shall add a few words.

38. Knowledge gained by practice is in all sciences of greater use than this speculation, although not according to the teaching of the method. For through the admiration of the results of experiments we are aroused to a study of causes. And therefore the practice of each science is by use and not by theory or speculation. Therefore speculation concerning the causes is necessary before we are able to know exactly the practice: but medical speculation depends particularly upon many sciences. For example, philosophical agriculture gives a knowledge of simple medicine which exists in plants and animals. Alchemy reveals the simple medicine which is found in inanimate things. But these two sciences are not known by ordinary people, not only doctors but all students: because not only are the inanimate and animate things which are in the medical books unknown, but also many of their words which, according to the nature and meaning of the word, are taken from the books on alchemy and agriculture. Natural philosophy, especially concerning the heavens, is very necessary in order to recognize the complexions of the places of the world and the times and, as a result, all medical things.

39. Now follows experimental science whose first merit is, as I have previously proposed, that it in itself gives complete proof concerning the conclusion of other sciences. For theoretical knowledge does not give the proof of its conclusions, but only

the principles, as ARISTOTLE (46) says at the end of the *Posteriora* and at the beginning of the *Metaphysica*. Other sciences, which are practical, although developed by means of experiments in respect to their conclusions, yet these experiments are either universal, or, if they are particular, are incomplete in respect to the final experiments, upon which this science is based : and without a testing of conclusions there never will be science. For evidence as a demonstration proves the truth of a conclusion which no one is able to refute, but not on this account does his mind rest in the light of truth : experiments are continually being demanded, and then the truth is comprehended without complaint or hesitation. And therefore since science is the ascertained knowledge of truth, truth is determined by proofs, but doubt is not hindered, however not by this is the certainty of facts brought to light before experimentation is added. And everyone has found this to be true in an infinite number of cases. Although everyone learns by proofs which he is not able to refute, and accepts the fact that fire is hot, yet not because of this does he shrink from putting his finger into the fire before he has experienced the pain; after this has been done, his mind is at rest in the knowledge concerning the strength of burning heat, and he avoids the effect. Because since the first demonstration of EUCLID is the most important, when it is stated that all lines drawn from the center to the circumference are equal, and each side of a triangle constructed upon a given line with the line of the same kind and therefore equal to each other, because things equal to the same thing are equal to each other, therefore that triangle must be equilateral : the mind of the listener is not at rest concerning this truth before the experiment of the figure of two circles intersecting each other, from whose intersection on both sides are drawn two lines to the extremities of the given line, but not because of this (demonstration) is this fully proved, unless there is in addition a particular experiment by measuring. And therefore when ARISTOTLE (47) says that demonstration is the logical method of producing knowledge, it may be proved by

(46) ARISTOTLE, Analytica posteriora, Book II, chapter 19, in *Works of Aristotle*, vol. VII, translated by G. R. G. MURE, Oxford 1926.

(47) *Ibidem*, Book I, 87*b*-88*a*.

its own experiment: whence he does not use this word absolutely and merely for the exclusion of any other one whatsoever, but for the exclusion of other kinds of proofs, those which are not of an experimental nature, and thus it is according to natural law. For anyone by means of an experiment, no matter how ignorant he is concerning the attraction of iron on becoming magnetized, can effectively prove by evidence that this attraction is possible in nature, although it has not yet been verified, unless he has seen it with his own eyes, so that each one may know it for himself. Because not so much by authority nor by reason, as by experimentation may we work this out, and then the mind is at rest.

40. It is said that tablets and pills purge the remote parts, because they lie for a long time in the stomach, and liquid substances, near ones. But in that case violet, if it were given in tablets, would purge the remote parts; purging cassia and tamarind and other light medicines of this sort and heavy medicines in liquid substances would purge distant parts, and this is not true. There are pills and tablets into which aloes is put because it is too bitter, nor could it be taken in a liquid substance on account of its bitterness: and aloes is better than honey according to the opinion of Master SIMON (48), because it has an affinity with the parts of the head, and he has proved by experimentation that aloes is more efficacious than honey.

41. The doctors of Salerno say that scammony should not be ground too finely, lest the powder adhere to the stomach, and lest it become so hot that the virtue leaves it. But there is nothing in the first statement; and the correction for the second is that it should be ground moderately, and cold water poured into it, and it will become like milk, and then it should stand until it is thoroughly dry.

42. There are three kinds of aloes, namely citrine, the only one which is ordinarily used by the Latins; and hepatic, which looks like cooked pig's liver; and red.

43. Opiates are given only after purgation, in order to destroy the remaining humors, except in certain cases, for instance when there is little humor and when it is moving to some particular

(48) SIMON DE CORDO, or JANUENSIS (d. 1305), physician to Pope NICHOLAS IV.

part of the body. For then it is better to draw back the humor than to suffer an important part to be destroyed. But it is not given in the correct proportion for that condition; and in the case of red opium which is given to check the heat in tertian fever, the results are not fortunate; nature seems to be destroyed and the man to fall into a frenzy.

44. Early *Antidotaria* begin with opiates, namely with *tyriaca* and others : then with electuaries : then with laxatives. SIMON saw the *Antidotarium* of COSMAS and DAMIAN in Italy and other early ones, and looked for the *Antidotarium* of ALAP which is in Hebrew, and the *Practica* of AVERROES (49).

45. The fermentation of drugs is of great value, for instance scammony should not only be pulverized and put into the medicine, since otherwise it will not be easily incorporated, but first it should be ground up in water until it has become like milk and then it may be incorporated with the medicine. In the same way, opium should first be ground up into water, then thoroughly dried, or mixed with honey.

46. Diagredium affects no illness except a humor such as choler and therefore in the *Benedicta* it is incorrectly given in the quantity of 5 drams, since 1 dram of scammony purges choler more than 1 ounce of hermodactyls and of those which purge phlegm. Therefore *Benedicta* purges not phlegm but choler : on account of this, the son of the man who made that *Benedicta*, added a large quantity of spurge and less scammony and called it *Benedicta transtiberina*.

47. The apostheme of the musk deer which has dropped naturally, has been scraped from the stomach of the animal and there are many grains, as many as a cube of grains, and it is reddish in color, and spherical in shape : that which is taken out before that time does not have mature grains; in the beginning there is a mass which looks like black coagulated blood; then nature divides that into twelve parts or about as many : then divides each of those into twelve, or about that number : and those who wish to adulterate it take some of that blood and mix it with

(49) The *Antidotarium Opopira* was dedicated to COSMAS and DAMIAN according to ARNOLD OF VILLANOVA, *Opera*, 322, Lyon 1532. I have not been able to find out anything about Alap. *Practica* of AVERROES, Book V, Colliget.

some of the mature grains, and thus deceive people, but it is blacker in color and is not so aromatic.

48. Lign-aloes, which is called wood aloes, is of a somewhat black color inside and out, if it is good; it sinks in water if it is broken into small pieces, and is like knots in wood, and is in it, and is started in its veins; but those who wish to adulterate it boil the good aloes and extract the virtue, and sell to the Latins the pulp without its virtue, or some of the wood in which it was growing.

49. Rhubarb is put into a liquid, and its virtue taken out, and it is sent over to the Latins, that is, in one and one eight *scutella* (50) of goat's milk, strained and boiled down with the whites of six or five eggs, above a flame, near to a moderate fire, in order that it may bubble gently until the cheese-like substance has all collected on top, and when it has been filtered again and well cooled, rhubarb which has been broken up into small pieces is poured into it, and the virtue is extracted in one short night in summer or a half of a night in winter, or about that much time, in order that it may be taken against cold humors, principally phlegm, and it should be filtered and well squeezed out so that all of the virtue may come out with the milk through a piece of fine cloth; and if it is again placed in a thin liquid and boiled vigorously, it is better than it was after the first straining. And better by far is rhubarb senith, that is Indian, than any other rhubarb : and if it is put in milk while it is warm, it will do nothing except ooze out. And one can drink the rest of the milk, and if weakened on account of fasting, which makes food pass from the stomach slowly, he can drink it and will void afterwards. And after he has taken this medicine, he should sleep for a little while, in order that it may better and more quickly pass from the stomach; but one should sleep for only a little while, that is, about an hour and a half or two hours, because if one sleeps too long it will evaporate through the body. A man can take one half ounce of the virtue of rhubarb. The rhubarb, which was mentioned in the second place, was ***barbarum***, and that was

(50) A *scutella* was a small flat vessel of rhombic shape. ' Scutula id est rhombus, quod latera paria habet nec angulos rectos ', from PAULY-WISSOWA, *Realenzyklopaedie*, « scutella ».

heavy and its reddish color appeared to be dispersed throughout its entire substance; and therefore the doctors said that it was better because it was more moist, and could be more easily cut up into small pieces. *Reu senith* is lighter than *reu barbarum*, and *reu barbarum* is lighter than *reu ponticum;* and *reu senith* is rather black in color, and *reu barbarum* is always found with smooth surfaces and therefore seems to be boiled. *Reu ponticum* is always found to be round and rough and therefore does not seem to be adulterated nor boiled.

50. Rhubarb senith and others purge phlegm, and increase the natural heat and strength of the body, but rhubarb senith is better than any other. It is given in tertian fever against choler, but does not purge choler except incidentally, but does purge phlegm, as ARISTOTLE said in the *Secreta*. For choler is easily drawn out on account of its lightness, and it follows all the humors which are purged, as JOHANNES DAMASCENUS says in the *Afforismus* (51), that every laxative draws out choler; and therefore the doctors are deceived. Master S. calculates that its virtue is good against a flux of blood, because its marvelous virtue gives strength.

51. Flowers of rosemary are very good against phlegm and melancholy, and against the infirmities of old age. Small branches which come from a great branch of black hellebore, are taken and placed in water and the hard substance which is in those little branches is drawn forth and thrown away as poisonous; but the surrounding bark is collected and is prepared with other drugs, and it purges all choler and therefore cures quartan of its choler. In fact its seeds purge the humor which causes grey hairs, and is good against stone.

52. Myrobalans is broken up and placed in glass bottles in the strong sunlight, and water is poured over it, water which when it becomes bitter is put into another glass jar, such as a glass *scutella*, in the sunlight, and water is again poured over the myrobalans until it becomes bitter, and then it is poured into those *scutellae*, and this is done many times until the water remains sweet, and this water which has been collected in the *scutellae* is dried up in the sun. For the sun takes out all the water and

(51) IANI DAMASCENI, *op. cit.*, *Aphorismus* 82, cf. note 8.

a gross substance is left which is called the virtue. Another method of extracting it is to place it in the sun, and a third method is to boil it down by fire. In a similar way turbith is prepared and its virtue extracted.

53. The root of the male peony is somewhat round, and the root of the female is somewhat spindle shaped covered with slender cones, and a great hump in the center; and powder is made from the root and placed with other things for paralysis because what passes over to the nerves and veins must be taken in food as JOHANNES DAMASCENUS desires in the *Afforismus* (52).

54. A good powder : take 1 dram each of castor and pellitory, 2 drams of cinnamon, and of grains of pepper, 1 dram of common salt, of the root of the female peony, and of the herbs penny royal and wild marjoram, and this is made into a powder. Moreover this powder is made in order that, according to the *Afforismus* of JOHANNIS DAMASCENUS, it may cross over into the fourth division and be changed in veins and nerves just as food is because otherwise the illness of the body is not cured. The root of the elecampane is cut up in round pieces and they are hung by a thread in the sun, in order that they may dry, because otherwise they would hold their moisture too long. This *pulegium* is not royal but is the true *pulegium*. For what in Francia is called *pulegium regale* is really wild thyme, like that found in Italy. The root of the long female peony is somewhat spindle shaped; this is not true of the male : who uses this may use it in food and drink.

55. Take 2 denarii of lign-aloes and it is best if it is thoroughly ground up by itself, and afterwards it is removed from the mortar. Then take 4 denarii of pearls; add 50 gold leaves, and grind them up together thoroughly, and when they have been well ground, add the powder of lign-aloes, so that it may become one substance : then it is removed; then put in 1/2 ounce of cloves and grind it up well : then everything is put in together and ground up well : then a Parisian obol (53) of musk is ground up by itself, then (bone of a stag's heart), if it can be secured, is ground up. Then take one half ounce of hard sugar and

(52) *Ibidem, Aphorismus* 60.
(53) An *obol* was equal to the sixth part of a dram.

grind it up by itself : then everything is put together and well ground up as this is the final quantity : then it may be easily kept.

56. Whoever uses gold should break it up very fine and pulverize it very minutely, and if they know how, should make it into a liquid and put it into milk or some other nutritive substance. Again, the gold leaves should be made very fine, and broken up very minutely : and also the pearls and the bone of a stag's heart and things of this nature : and the powder is made very fine and is put into milk or some other sweet thing or some such liquid, and is taken for faintness, and tremors of the heart and diseases of this kind, and against greediness, in cases where other maladies cannot be cured unless greediness is removed.

57. Mead is made of eight parts of water and nine of honey, therefore water is in an octupled proportion.

58. It is necessary that a doctor look up in the *Book of leprosy*, the putrid juices which come from four humors, either simple or compound according to their constitution.

59. These (drugs) are lacking among the Latins : red aloes which is called Indian, and Persian hepatic aloes which is citrine, just like the liver of a pig when it has been cooked; that which is called Arabic citrine aloes, which is black, is found among the Latins; and there is a certain succotrine aloes.

60. Epithymon of Babylon or of the island of Crete; rhubarb senith of India, because *reu barbarum* and *reu ponticum* are to be had : and it is difficult to distinguish between these three kinds of rhubarb. Whence sometimes in the books *reu senith* is called *barbarum*, and one is used instead of the other, because *reu senith* has not been correctly recognized : but that rhubarb is best for phlegm, and *reu ponticum rotundum* comes to the Latin countries. *Reu barbarum* has a smooth surface and is not round and therefore it is thought that *barbarum* cannot be taken for *ponticum*, or the virtue extracted by the Saracens. And *reu ponticum* is better than *reu barbarum*, and they are of the same price.

61. Lizard's dung is round and white and black in color; lizard's dung or theofic' are black grains which the people across the seas use in medicines for the eyes.

62. Oil of sesame, that is of a certain herb or tree or seed, is a common food beyond the mountains just like olive oil with us.

Also fresh balsam. Also good unadulterated musk. Also Indian wood aloes not boiled. Also viper's flesh from mountains which are not rocky, and by their teeth it is known whether they are male or female (54).

63. In the *Viaticum* it is called *diaquilon* when one takes equal amounts of scariola, and smallage, fennel, rock parsley, and this is good against cold dropsy and other things of this nature. Also pills of viper's flesh with spices and often with cinnamon is good for such dropsies.

64. The serpent *(draco)* which the Ethiopians alone know (55), and the snake *(coluber)* which has a red line on its back from the head to the tip of the tail and a red circle around its neck, and the viper *(tyrus)* are edible. But that snake is good against the diseases of old age and leprosy. However viper's flesh is by far the best for the diseases of old age, and is the drug of the poisonous variety concerning which HALY, etc.

65. Joyfulness, singing, the sight of human beauty, the touch of young girls, warm aromatic water, the use of spices and strengthening electuaries, bathing on an empty stomach after getting rid of the superfluities, protect and increase health and life.

66. Flowers of wild thyme are taken and put into a copper or iron or an earthen jar lined with lead, and the top is closed up, and smeared with ointment made from the whites of eggs and meal, and placed in a drinking cup or a cooking pot bubbling from morning up to the third hour or about that time, until it becomes an oily substance and the oil is squeezed out, and it is very good for cold humors.

67. Camomile is especially like the human constitution, as AVICENNA says (56), and if oil is made from it, as from the flowers, it is considered to be good against the diseases of old age. In the same way if oil is made from rosemary, it is certainly made from the flowers of penny royal, which is not wild thyme, used

(54) AVICENNA, « Ars trochiscorum de viperis... Et eorum signum, quod masculi in omni latere habent unum dentem, et foeminee plures uno... », *op. cit.*, Liber V, I, 1.

(55) AVICENNA, « De dracone. ... Et dixerunt quidam, (cf. Aeti. lib. 4) quid ipsi multiplicantur in partibus Nubiae (Ethiopia) et Indiae, et Indi sunt maiores, et illi de Nubia, qui sunt in regione Asiae, sunt usque ad quatuor cubitos : et Indi sunt magni valde, » *op. cit.*, Liber, IV, VI, IIII, 53.

(56) AVICENNA, *op. cit.*, Liber II, II, 118.

in salts and with meat, but real penny royal having large fistules or branches, when the flowers have been placed in a jar of leadlined earth covered with a linen cloth, having been mixed with the whites of eggs and meal, are then placed in a pot or small vessel full of boiling water from morning until the third hour or about that time, and it is pressed and the oil which is thus made is very good for colds.

68. Flowers of camomile are taken and are ground up with olive oil, and the glass jar is refilled to the measure of an urn or one flagon almost up to the neck, and they are hung in a jar full of water, so that the circle of cloth or something else is about the neck, and a stone hangs down by a thread, not however down to the bottom of the vessel in which the water is, but the stone floats beneath the glass vessel and it holds it down. Then as the water is consumed by boiling, fresh water is poured in up to the top of the flowers : because it should always be up to the top of the flowers, and that water which is poured in should be cold, it seems to me, lest the glass vessel be broken, for experience has proved this.

List of drugs mentioned by Bacon

Those marked with the asterisk are discussed in the *Glossary of drugs* below.

BACON's method of spelling has been retained in all cases.

The numbers refer to the paragraphs in which each word is found.

*Aloes, aloes, 40, 42, 59.
*Aloes citrinus, yellow aloes, 10, 42, 59, 62.
*Aloes epaticus, hepatic aloes, 10, 42, 59.
*Aloes rubeum, red aloes, 42, 59.
*Anacardum, fruit of an anacardiaceous tree, 6.
Antos, flos rosis marini, rosemary, 51, 68.
*Apium, smallage, 63.
Apostema gazel, musk, 1, 10, 26, 47, 55, 62.
Aqua rosacea, rose water, 16.
Argentum, silver, 31.
Argentum vivum, quick-silver, 18, 31.
Aristologia de terra, birthwort, 10.

Aurum, folium aurum, gold, gold leaf, 31, 55, 56.
*Balsamus, balsam, 1, 10, 27, 62.
*Benedicta, a compound drug, 7, 46.
Benedicta transtiberina, a compound drug, 7, 46.
Calce cumenon, copper, 31.
Camomilla, camomile, 68, 69.
Capit draconis, head of the dragon, 16.
Carnes tyri, viper's flesh, 1, 4, 6, 10, 16, 27, 62, 63, 64.
*Cassia fistula, cassia, 40.
*Castoreum, castor, 54.
Ciminum, cumin, 54.
Cinamomo, cinnamon, 63.
Coluber, serpent, 64.
*Diagridium, diagrideum, 7, 8, 46.
*Diaquilon, diachylon, 63.
Draco, dragon, 64.
Elleborus niger, black hellebore, 51.
Enule, elecampane, 54.
*Epithimum de Babilonis vel de Creta, epithymon of Babylon, 60.
Esula, spurge, 64.
Feniculum, fennel, 63.
Gariofili, cloves, 55.
Hermodactilus, hermodactyls, 7, 46.
Lapides pretiosi, precious stones, 31.
*Lignum aloes, xiloaloes, lign-aloes, 1, 4, 10, 27, 31, 48, 55, 62.
Margarita, a pearl, 55, 56.
Mel, honey, 40, 45, 46.
Minium, red lead, cinnibar, 31.
*Mirobalanus, myrobalans, 4, 31, 40, 52.
Mulsum, mead, 57.
*Muscus, musk, 1, 10, 27, 46, 55, 62.
*Oleum benedictum a lateribus, blessed oil of bricks, 16.
Oleum olive, olive oil, 62, 69.
Oleum sisami, oil of sesame, 10, 62.
Opium, opium, 5, 8, 43, 44, 45.
Origanum, wild marjoram, 54.
*Os de corde cerui, bone of a stag's heart, 1, 28, 55, 56.
*Petroleum citrinum, oil of Peter, or oil of rocks, 10.
Petrosillium, rock parsley, 63.

Pionie femine, feminine peony, 53, 54.
Pionie masculi, masculine peony, 53, 54.
Piperis rotundi, pepper, 54.
*Piretrus, pellitory of Spain, 54.
*Pulegium regale, penny-royal, 54, 68.
Pulegium verum, true penny-royal, 54.
*Reu, rhubarb, 1, 3, 4, 16, 30, 49, 60.
*Reu barbarum, 26, 27, 31, 49, 60.
*Reu ponticum, Pontic rhubarb, 26, 27, 49, 60.
*Reu senith, cenith, senith rhubarb, 10, 26, 49, 50, 60.
Rubea opiata, red opiate, 43.
Sal communis, common salt, 54.
*Scamonea, scammonia, scammony, 5, 7, 41, 45, 46.
Scariole, endive, 63.
*Sene, senna, 3, 30.
*Serpillum verum, wild thyme, 54, 67, 68.
*Squinanti, squinanth, 10.
Stercus lacerti vel theofic', lizard's dung, 61.
Sulphur, sulphur, 18.
*Tamarindi, tamarind, 40.
*Turbith, turbith, 52.
*Tyriaca, a compound drug, 1, 6, 43.
Uzifur, cinnabar, 18.
Uzifur mineralis, mineral cinnabar, 18.
Viola, violet, 40.
Zuccarum durum, hard sugar, 55.

Glossary of drugs

Aloes, *aloes*, a very bitter drug made from the inspissated juice from any one of several species of aloes. The best kind of aloes is the Socotrine most of which came from the island of Socotra. BACON's *aloes citrinus* was undoubtedly Socotrine, cf. AVICENNA, *Liber canonis de medicinis cordialibus*, II, II, 64, Venice 1582, « Aloes quid est : Est succus congelatus inter rubedinem, et citrinitatem existens. Et eius aliud est succutrinum, aliud arabicum, et aliud est semegenium. Illud, quod melius est, est succutrinum : cuius aqua est sicut aqua croci, et odor eius est sicut odor myrrhae. »

Red aloes, *aloes rubeum*, is supposed to be a variety of Socotrine.

Hepatic aloes, *aloes epaticus*, was an opaque, liver-colored form of Socotrine.

Another medieval kind, not mentioned by BACON, was the *Aloe caballina :* « There are three several sorts of Aloes differing only in purity, viz. Aloe Caballina, Aloe Hepatica, Aloe Succotrina : the first is only given to horses : the second both to horses and men, this sort looks like liver : the last is the best, which being broken thin is transparent, and being powdred is of a good yellow colour. » *New London Dispensatory*, 154, London 1678.

Anacardus, *anacardus*, fruit of an anacardiaceous tree. The shell yields a blackish resinous juice. « Anacardus quid est : Est fructus similis ossi tamarindorum. Et medulla eius est similis medullae amygdalae dulcis, in qua non est nocumentum. Et cortex ipsius est rarus, perforatus, vel habens foramina, in cuius raritate est mel viscorum habens odorem. » AVICENNA, *op. cit.*, Liber II, II, 40.

Apium, *apium*, a form of wild celery *(apiaceae)*, similar to smallage, « Aliud est montanum, et aliud sylvestre, et aliud domesticum : et aliud est, quod oritur in aqua et in loco aquae propinquo. » AVICENNA, *op. cit.*, Liber II, II, 55.

Balsam, *balsamus*, the balsam to which BACON refers must have been that which was cultivated by the Arabs around Mecca and sent from there by caravan to the apothecaries of Spain and other western European countries, cf. W. HEYD, *Histoire du commerce du Levant au moyen-âge*, II, 575-580, Leipzig, 1886. Balsam extracted from the fruit *(carpobalsamus)* or from the branches *(xylobalsamus)* was inferior to that obtained by incision *(opobalsamus)*, and therefore much cheaper. According to HEYD *opobalsamus* was never mentioned in the books of commerce; but it is mentioned in the *Reichnauer Antidotarium* in the *Antidotus polichristus a Marcello acceptus*, edited by H. E. SIGERIST, Studien und Texte zur frühmittelalterlichen Rezeptliteratur, in *Studien zur Gesch. d. Med., H.* 13, p. 41, Leipzig, 1923. This *opobalsamus* may have been the « pure balsam » advocated by BACON.

Benedicta, a compound drug. The *Benedicta Laxativa* or

Benedicta Nicolai used in Salerno. It consisted mainly of turbith, diagridium, hermodactyls, and other purging drugs. For two French translations of the *Antidotarium Nicolai* (NICHOLAUS PRAEPOSITUS) in which there are two recipes for the *Benedicta* see the edition by P. DORVEAUX, p. 6 and p. 108, Paris 1896.

Bone of a stag's heart, *os de corde cerui*, the following explanation of this term was kindly contributed by Dr. EDWARD KREMERS of the University of Wisconsin, « Ce n'est autre chose que le concours des artères dans la base du cœur, lequel par succession de temps s'endurcit, et dégénère en os. Il a une faculté spécifique pour fortifier le cœur, et pour le défendre de toute malignité, » from *Dictionnaire Pharmaceutique ou Apparat de Médecine, Pharmacie et Chymie*, 169, 1689.

From two other works of BACON we get a repetition of the ancient story that the medicinal value of the bone of a stag's heart is due to the astounding age to which it was possible for that animal to live, « Sed humiditas animalis longe vite non est sanguis, sed cartilago quedam que in corde eius invenitur. Nam dicitur quod hoc animal non ex senectute moritur, sed ex accidentibus aliis. Unde inventum fuit hoc animal in monte anonie, in cuius collo inventus est circulus in quo erat scriptum : Hoc animal fuit in hoc nemore positum tempore Iulii Cesaris. Et dicitur quod cor illius animalis sepe comestum naturalem calorem excitat et confortat. » *Incipit expositio predicte Epistole*, A. G. LITTLE and E. WITHINGTON, *op. cit.*, 88, and cf. 43. According to PLINY's theory stags had been known to live for at least a century.

Cassia fistula, this is not the cassia fistula of the ancient writers which was a bark related to cinnamon, but a cheaper variety of cassia (from the pulp of the pudding-pipe tree) akin to senna. F. A. FLÜCKIGER and D. HANBURY, *Pharmacographia*, 195-197, London 1874.

Castor, *castoreum*, a secretion of the beaver, having a strong odor. Used in medicine as an anti-spasmodic.

Diagredium, *diagridium*, a drug of the same family as scammony for which it was frequently substituted. HEYD, *op. cit.*, II, 670.

Diachylon, *diaquilon*, this was not like our diachylon but was a plaster made of the juices of several plants. « Lini semen emina, fenugreci emina, visci libra duo, rosa sicca libra una, malua saluatica radices ℘ II, hec infundas in aqua sextar. XVIII et olei ℘ III, spuma argenti ℘ III, cera libra VI, decoquis lento igne et uteris. » *The Bamberger Antidotarium* (IX-X century), H. E. SIGERIST, *op. cit.*, 39.

Epithymon, *epithimum*, the flower of thyme. « Epithymum quid est : Est semen, et flos, et stypites parui frangibiles, et est calidum acuti saporis semina habens rubea, cuius plantae virtus est, sicut virtus alhasce, (thymi), verum halsce (thymum), est debilior eo, et dicitur, quod est de genere alhasce (thymi). AVICENNA, *op. cit.*, II, II, 225.

Lign-aloes, *lignum aloes*, the lign-aloes which was used in the Middle Ages was not the aloes used to-day, but was the resinous wood of the *Aquilaria Agallocha*. « *Agalochum, Lignum Aloes*, it comes to us in chips which are heavy, bitter, of a Blackish purple colour with ash coloured veins, of a sweet sent, and if they be good, they will swim when put into water. » *The New London Dispensatory*, 24. In the east it was used as incense but in the west, introduced by the Arabs, as a drug. F. A. FLÜCKIGER and D. HANBURY, *op. cit.*, 616, note 1. HEYD, *op. cit.*, II, 582.

Musk, *muscus*, a secretion of the musk deer. In the Middle Ages it was imported from India, Tibet, and China. Although rare in the west, it was frequently used by the doctors of Salerno. On account of its costliness it was seldom found among the articles of trade. HEYD, *op. cit.*, II, 639.

Myrobalans, *mirobalanus*, a fruit, similar to a prune, from trees which grew in India. A very common article of trade and frequently used in the Arabic and Salerno medical works. « Myrobalani quid est : Eorum alii sunt citrini immaturi : et alii sunt nigri Indi, et sunt illi, qui ultimi sunt in maturitate, et sunt pinguiores : et alii sunt Kebuli, qui sunt maiores omnium : et alii sunt sinii, qui sunt minuti et leviores. » AVICENNA, *op. cit.*, II, II, 449.

Oil of Bricks, *oleum benedictum a lateribus*, « Recipe Roots of Carduus and Valerian, ana ℈ ii, flowers of Hypericon ℈ ii : Wheat; ℈ iss : very old Oyl ℈ iiii : Cypress Turpentine,

℈ viii : Frankincense poudred ℈ ii : the Roots and Flowers being bruised, put to them white wine enough to cover them; digest two daies in a pot, then put in the Oyl with the Wheat beaten, which boyl together till the wine is evaporated : strain, and adding the Frankincense and Turpentine, boil again a little, and keep it ». *The New London Dispensatory*, 732.

Oil of Peter, or oil of rocks, *petroleum citrinum*, « It is a kind of fat flowing from Rocks or Stones : whether it be vegetable or mineral, it is doubtful; this is certain, that being inspissated it much resembles a gum. » *The New London Dispensatory*, 169.

Pellitory, *piretrus*, a very hot (Algerian) root, used for making a medicinal drink. DU CANGE, *Glossarium Mediae et Infimae Latinitatis*, « *piretrus* », V, 265, Paris 1845. It was later called pellitory of Spain.

Penny-royal, *pulegium regale*, the name comes from the Latin *puleium* (fleabane) because the plant was supposed to destroy fleas *(pulex)*. « De mescatramescir, i. Dictamno et pulegio, Mescatramescir quid est : Stipites similes alasahesefram sicco ex quo non assumitur in principio cibi sapor plurimus neque odor, deinde succedunt amaritudo, et acuitas... Et est duarum specierum, quarum una est mescatha mesiha verum, et altera est mendosum falsum, et est ei simile : « AVICENNA, *op. cit.*, II, II, 461.

Rhubarb, *reu*, there does not seem to be any agreement among medieval writers concerning the different kinds of rhubarb. The younger Mesuë (d. 1015) says the rhubarb of China (the original home of the medicinal rhubarb) is better than *reu barbarum (reu officinalis)* or Turkish. Constantinus Africanus (d. 1087) says that Indian is better than Pontic Rheum. Most of the rhubarb used in the twelfth century probably came from India. According to Little and Withington senith rhubarb must have come from northern China, *op. cit.*, 223. For an interesting discussion of this question see F. A. FLÜCKIGER and D. HANBURY, *op. cit.*, 442-451.

Scammony, *scammonia, scamonea*, the juice from the root of the *convolvulus scammonia* plant. One of the most popular purgative drugs of the Middle Ages, that from Antioch being preferred. HEYD, *op. cit.*, II, 669-670.

Senna, *sene*, the most popular purgative drug in the Middle Ages.

Wild thyme, *serpillum*, not like the present garden species. « De Nemem (Nemam) i. Serpillo vel sisymbrio, » AVICENNA, *op. cit.*, II, II, 507.

Squinanth, *squinanthi*, a grass of Northern and Central India from which an oil was made.

Tamarind, *tamarindus*, often called Indian date. A very popular drug among the Arabs and doctors of Salerno.

Turbith, *turbith*, a convolvolaeous tuber, allied to scammony, similar to Mexican Jalap.

Tyriaca, *tiriaca*, cf. our treacle. A very ancient and fashionable drug used by NERO, MARCUS AURELIUS and others. A recipe for it may be found in practically every *Antidotarium* of the Middle Ages, although each contains slightly different ingredients. Cf. *The Bamberger Antidotarium*, »... coloquintidu interiones dragma uiginti, aristolagia rotunda, appii semen, spica nardi, petrosilino, croco, cassia ana dragma dece, trifolii acuti semen, cardamoni, etc. » H. E. SIGERIST, *op. cit.*, 29.

A list of the authors and their works (those not in parentheses) mentioned by Bacon

ALKINDI (AL-KINDĪ), *(De medicinarum compositarum gradibus investigandis libellus)*, 33.

ALAP, *Antidotarium*, 44.

ARISTOTLE, *Analytica posteriora*, 39.

ARISTOTLE, *De plantis*, 21.

ARISTOTLE, *(De sensu et sensibili)*, 19.

ARISTOTLE, *Elenchi*, 13.

ARISTOTLE (?) *Lumen luminum*, 22.

ARISTOTLE, *Metaphysica*, 13, 19, 31, 39.

ARISTOTLE, *Metheora*, 21, 31, 32.

ARISTOTLE, *Topica*, 13.

ARISTOTLE, *Secreta secretorum*, 3, 14, 16, 22, 26, 27, 30, 50.

AVERROES, *Practica*, 44.

AVICENNA, *Liber canonis de medicinis cordialibus*, 1, 3, 6, 8, 16, 17, 18, 22, 25, 30, 31, 34, 36.

CONSTANTINUS, 14.

GALEN, 14, 17, 22, *Dinamidiarum*, 31.
HALY ('ALĪ IBN 'ABBĀS), *(Liber regius)* 3, 14, 30, 36, 64.
HALY SUPER TEGNI ('ALI IBN RIḌWAN) *Commentator*, *Galen*, *Microtegni*, 2, 29.
HIPPOCRATES, *(De aere, aquis, et locis)* 14.
ISAAC ISRAELI THE ELDER, 14.
JOHANNES DAMASCENUS, (SERAPION THE ELDER) *Therapeuticae methodi*, 3, 8, 50, 53, 54.
JOHANNES PLATEARIUS THE YOUNGER, *(Practica brevis)*, 31.
MICHAEL SCOT, translations of ARISTOTLE, 21.
PLINY, *(Historia naturalis)*, 21.
PTOLEMY, *(Quadripartitum)*, 14.
RHAZES, (AL-RĀZĪ), *(Continens) Divisiones*, 14, 25.
SIMON DE CORDO, or JANUENSIS, 40, 50.

Harvard Library 189 MARY CATHERINE WELBORN.
Cambridge, Massachusetts.

Rufinus: A Forgotten Botanist of the Thirteenth Century

The botany of the middle ages has commonly been held in low esteem. The illuminations in the manuscripts of the PSEUDO-APULEIUS and other medieval herbals have been criticized as creations or copies of the artist or as his faulty reproduction of previous traditional illustrations which originally bore some resemblance to reality. So that, much as GIBBON viewed the history of the middle ages as the decline and fall of the Roman empire, historians of science have regarded medieval botany as little more than the decline and fall of DIOSCORIDES. If EMILE MÂLE, from his study of Gothic cathedrals, called attention to the accurate knowledge and faithful reproduction in stone of the flora characteristic of each locality, this was set down to the credit of the genius of the Gothic sculptors, though MÂLE himself had demonstrated how closely in other respects the medieval artists adhered to or paralleled the literature and learning of their time. As if a sculptor would know flowers better than a professional *herbarius* or herbalist would! MEYER, it is true, in his history of botany lauded highly ALBERTUS MAGNUS who had developed ALFRED OF SARSHEL's translation of the scanty two books of the PSEUDO-ARISTOTLE on plants into the seven books of his *De vegetabilibus et plantis*. But this estimate of ALBERTUS as the greatest figure in the history of botany between THEOPHRASTUS and CESALPINI rather distinctly implied that there was no one like him in the long intervening period. Of late years, however, more attention and study has been devoted to medieval botany, and such a recent book as HERMANN FISCHER's *Mittelalterliche Pflanzenkunde* assembles much valuable material from manuscripts as well as printed works.

Yet I shall now call attention to a medieval botanist whose

work and personality appear hitherto to have remained unknown to modern investigators. His name does not appear in the index of *Mittelalterliche Pflanzenkunde*, but FISCHER, in listing after DE TONI (1) the citations in the *Herbarius* of BENEDETTO RIVIO early in the fifteenth century, notes that a RUFINUS is frequently cited and that he was probably VALGIUS RUFUS, author in 12 B.C., according to GALEN, of a didactic poem *De herbarum virtutibus*. (2) Such far-fetched resuscitation of a classical author is not necessary : we must look nearer home. The RUFINUS whom RIVIO cites undoubtedly was the author whose work I have found and which was composed by him not long after the death of ALBERTUS MAGNUS. In fact, he seems ignorant of the existence of *De vegetabilibus et plantis* which he never cites, and which there is no evidence that he plagiarized. On the contrary, many of the herbs treated by RUFINUS are not included by ALBERTUS, and, when the same plant is discussed by both, it is in quite different style.

RUFINUS apparently was an Italian. He is also called a holy doctor, but this seems less likely. In his prologue he tells us that he had studied the liberal arts at Naples and Bologna. He specialized first in astronomy and then, turning from superiors to inferiors, decided to examine fully and perfectly the science of herbs. The results of his researches are preserved in a large and handsome folio volume of some 118 leaves, written with red and blue initials on membrane in double columns, except the first sixteen leaves which are devoted to an index written in three columns. Formerly in the possession of Lord ASHBURNHAM, it is now in the Laurentian library of Florence. (3) This is probably not RUFINUS' autograph but a fourteenth century copy. The title of the work is, *Of the Virtues of Herbs and of their Compositions*. (4) At first glance it might pass for a mere compilation

(1) ETTORE DE TONI, " De libro dei semplici di Benedetto Rivio," *Memorie della Pontificia Accademia Romana dei Nuovi Lincei*, vols. 5, 7, 8 (1919-1924).

(2) FISCHER, *Mittelalterliche Pflanzenkunde*, Munich, 1929, p. 230. (*Isis*, 15, 367-70).

(3) Ashburnham 189 (121).

(4) *Ibid.*, fol. 17*r*, col. 1 : rubric, " Incipit liber de virtutibus erbarum et de compositionibus earum compilatus per sanctum doctorem magistrum Rufinum de dictis summorum phylosophorum Diascoridis, Circa Instantis, Macri, Alexandri, Salerni (magistrorum), Ysaac et quamplurimum aliorum doctorum "; incipit,

from previous authorities, primarily medical. RUFINUS himself gives this impression in the prologue, saying, " And I have collected from the sayings of the ancient sages describing the virtues of the herbs and their workings in inferior bodies according to what they had experienced and the truth they were able to find concerning these. And first I quote the words of DIASCORIDES, second *Circa instantis*, third MACER, fourth ALEXANDER THE PHILOSOPHER, fifth the masters of Salerno, sixth ISAAC, seventh the *Synonyms*." This is assuredly a program which promises nothing either original or even up-to-date in RUFINUS' work. And at first sight he appears to adhere to it faithfully. He occasionally cites other authorities than the seven listed. COPHO and PLATEARIUS will perhaps fall under the head of masters of Salerno, but ROGERIUS and a master WILLIAM are also cited, not to mention GALEN, PTOLEMY, and JOHANNITIUS. These variations, however, are comparatively unimportant.

But presently we observe that, after the authors have been cited, there come at the end of the treatment of the herb in question a few lines introduced by the word, RUFINUS. Or sometimes no authors at all are cited for an herb. Or the only name mentioned is RUFINUS. And finally we realize that many herbs are discussed which were treated not merely by only one or two of the seven authorities, but which had not been mentioned by them at all. It is in these modest additions to his authors and the filling in of gaps where authorities were totally wanting that RUFINUS' contribution to the science as well as to the literature of botany consists.

The medieval literature on herbs has hitherto been represented as subordinated to pharmacy. Herbs, we have been told, were valued for their supposed marvelous healing properties and not studied *per se* and for their own sake. It is just this assumption that the work of RUFINUS contradicts. For precisely what his additions to his authorities consist in is careful detailed description of the plant itself, its stalk, leaves, and flower, painstaking distinguishing of different varieties of it, or differentiation of it from or comparison with other similar or related flora. He also is careful to inform us as to other names applied to a given

" Cum emereris ineffabilis virtus corpus perfectum nec in aliquo diminutum scilicet mundum disposuerit... "

herb, or other plants indicated by the same name, so that his work, if rendered available by publication, would constitute a most useful work of reference for those having occasion to deal with the vexed question of the medieval names for herbs.

But it is the descriptive side of RUFINUS' botany that I wish especially to bring out here, and this may be best and most faithfully done by reproducing a number of his passages which were selected practically at random, omitting many others. It will perhaps also be most convenient in reproducing them to maintain his own alphabetical—or nearly so—order. I leave the names of the herbs in Latin as RUFINUS gives them. His very condensed language at times makes translation difficult and the abbreviated writing of the manuscript sometimes leaves the spelling of the name of a plant in doubt.

RUFINUS's addition to what his authorities have said of *aristologia* is as follows : " The long *aristologia* has long pointed leaves and a yellow flower and long root. The round *aristologia* has round leaves and a black flower and a round apple on its root. The fruit of both are called by the common people *terrumalium*. They hang from the branches. Or they are called *mellumcelli* by the same laymen." ALBERTUS, like RUFINUS' authorities, has an account of *aristologia* and mentions the long and round variety, but RUFINUS's own additions are not paralleled in ALBERTUS's work.

" *Auricula leporis*. It has a very thin little branch and at the top white flowers. Its leaves are like those of *acetosa* but much blacker and without fuzz. And if it is touched with the hand it is sticky and clinging. Its root is full of nodes, and close to the earth it has many leaves like the leaves of salex. And it is medicinal." ALBERTUS MAGNUS mentions *auricula muris* (mouse's ear) but not this hare's ear.

" *Aurigea duplex*. It is also called *paradella*. It grows so to speak everywhere. Its leaves are half a finger long and narrow like the leaves of *cauliculus agrestis* and are crenated. It has a very thick stem a cubit high and many leaves. Its white flower is on top only and is like the flower of *cottula foetida* in color and magnitude. Its seed is put in medicines. There is also another *aurigea* having one purple *(violaceum)* flower at its top. But note that the aforesaid *aurigea* with the white flower and

called *paratella* is wonderful beyond measure in curing cuts in one or two days. There is still another *aurigea*, as it is believed smaller. It is like *tursulum* but its leaves resemble the leaves of *tanavete* (*canavete* or *cavanete* or *tavanete* are other possibilities) and at the end of its branch are sometimes white flowers but not so large as those of the large *aurigea*." ALBERTUS included neither *aurigea duplex* nor the three following herbs.

" *Aucheta* is a shrub a cubit high with thick crenated leaves and many flowers purple and yellow at its summit. There is also another *aucheta* with which the earth is full, and it is like mountain *polium* in its leaves and is also called *sticados*. It grows in sandy soil and is also called the herb of St. Mary and *canusula*. And crushed in lye it dyes the hair a golden color if anyone washes it with that lye. Note that in many places *aucheta* is called *bethonica*. It too makes the hair golden as the women say."

" The herb *aucha* has a twisting stem *(facit gambam*—an Italian word frequently employed by RUFINUS—*ut volubilis)* and climbs hedges and trees. Its leaves are flat, not round nor curly, like the leaves of *fraxinus*.

" *Athanasia* has the other names *donageta* or *atanacetum*, that is, *matricaria* (or possibly, *matricis cura*). It grows in the midst of gardens, has a stalk a cubit high or more with five or six yellow flowers at the top. It is good for pain of the womb taken as food or drink."

Passing over several descriptions of herbs whose names begin with B which appear to be by RUFINUS since no other author is cited and which are not found in the *De vegetabilibus et plantis* of ALBERTUS, we come to camphor. RUFINUS describes it as a gum which will burn in water as bitumen does in oil, if it is placed on something light to support it on the water while it is burning. " So camphor burns on water and this I have proved and it is true." ALBERTUS had also discussed camphor but without noting this property of it. Instead he told how fond leopards were of the camphor tree and attempted to give an explanation why smelling of camphor checked sexual appetite in men but aroused it in women.

" *Caput galli* grows in the woods and is an herb with many branches and black leaves. Another kind with white leaves is feminine and thin and has stems grouped in squares [or, by fours].

The flower of this herb is marvelous to see because it is the length of a finger making four acute angles and on each side has a round concavity and is, like a pine, large at the bottom and sharp at the top, and above the angles issue florid tongues in all directions, and the leaves which are beneath the flower are turned towards the earth. And it does not grow beyond a cubit, and in it are many secrets. Moreover, there is another similar to that herb in leaves and flower which is called dragon's head *(caput draconis)*, but its flower is red or purplish, and it emits little yellow flowers from the large flower." ALBERTUS does not treat of either the cock's head or dragon's head.

" The stem of ***centaurea maior*** is round, shiny *(lucida)*, and very green : The leaves are like those of ***mater silve*** though small, and the stem goes through the middle of each leaf, and between successive leaves there is a space of four inches, and at the top of the stem are many yellow flowers. The height of the stem is about a cubit, and its taste is very bitter, but in its flowers are eight very yellow leaves."

" There is also a ***centaurea media*** of which the above cited philosophers make no mention, and concerning which all the herbalists of Bologna and Naples were in agreement. But perhaps the aforesaid philosophers classed the medium with the minor as a single variety, because those two have a certain similarity in leaves and flowers. Nevertheless this ***media centaurea*** has many stalks on a single root and has leaves like ***majorana***, and the leaves are three fingers apart and are sharp and narrow, and two little branches go out of two leaves, and at the top are many little purple flowers."

" ***Centaurea minor*** grows during the last of May, and it has only one stalk on one root. Its leaves are like those of ***centaurea media***, and its flower is of the same shape but smaller, white and purple for the most part like the ***media***. And it is a tiny plant and acrid."

ALBERTUS who treats of the ***centaurea*** does not distinguish the ***media*** variety, but does say that there are two kinds of the ***maior***, one green, and one yellowish in its stalk.

" ***Coclearia*** grows in fountains and very cold water. Its leaf is very glistening and is almost exactly like the leaf of the wide plantagenet in every respect." ALBERTUS omits it.

So much for a few selections from herbs beginning with the letter C. We have passed over *Caro manna*—possibly a corruption for *cardamomum*—to which a whole column was devoted, *Centum-gumma* to which Rufinus devoted six lines, *Celidonia* where he added only two lines to his authorities, *Centrumgalli*, *Cinoglossa*, *Cicuta* where he added a half column of his own to a half column from his authorities, and *Cicer imperatoris* whose treatment was entirely his own. Most of these plants are not described by ALBERTUS MAGNUS.

Under D RUFINUS treats the same two herbs as ALBERTUS does but differently. He almost doubles in length the account of dittany and adds to nearly a page from authorities on *daucus* the statement that there are three kinds : " *Daucus asininus* and it is called *pastinata* and likewise *baucia*. And there is *daucus Creticus* which is called *cartuge* and there is another noble *daucus* which is called *affanaria*. Furthermore there is a *daucus* which is called *pastumcellus*. Its seeds cling to one's clothes. It is given for cricks,—*detur pando* (?)." ALBERTUS has only four lines on dittany and his account of *daucus* seems limited to the Cretan variety.

As for Hellebore *(Elleborum)*, " I, RUFFINUS, seeing that those herbs are deadly poison did not wish to treat of them as medicines and I have omitted the statements of the sages who spoke unduly of them and their medicinal properties because they cannot be used without danger of death." As for the difference between *pes lupinus* and black hellebore : " Black hellebore has a round stalk and seven leaves on top, two leaves open inside cut in three and two simple leaves next these and three leaves after those two divided into three parts. Others call *branca lupina* what the Romans call *pes lupinus*, but it has ten leaves or nine, all simple, and has a hollow stem. " ALBERTUS treats of hellebore differently.

" The root of *enula* pulverized and put in wine gives the greatest relief to the nerves. Cooked in wine it helps paralysis. *Salvia* cooked in wine is also wonderful for paralysis. *Enula* has broad white leaves and a stem and flowers, and mandragora similarly but without the stalk. Furthermore a certain priest a hundred years old ate often and yet again of the root of *enula* both raw and cooked, and he saw as clearly as a boy, as master Antony

used to tell." ALBERTUS says nothing of this priest, nor is the rest of his account of *enula* identical.

We omit a slightly longer addition to Heliotrope *(Eleotropium)*, pass over four columns on electuaries, a column on endive *(Endivia)* which seems to use no authorities, a column on *Esula* of RUFINUS' own and what a PETER DE CASTEIONO " told me in the kindness of his heart," briefer additions to *Eupatorium*, *Filipendula*, *Gita*, and a treatment of *Genuisse* which is all by RUFINUS, but note his addition to past accounts of gentian.

" *Gentiana* has leaves like *Sambucus* and at the top of each stalk has three leaves. Each leaf is divided into three parts and one division is higher than the other, and the leaves themselves are very fine in substance though broad enough. A gross gentian is brought from Verona, but the delicate variety grows round Bologna." This passage is quite different from ALBERT's paragraph on gentian, and he does not mention the next herb.

" The herb *lunaria* has a stalk almost three cubits high of azure color, and there are many nodes at distances of three fingers apart, and at each node are three leaves. It has occult properties of which I say nothing for the present. A certain herbalist told me that the herb *lunaria* has a root a span in length with three little branches, one at the head of the root, the other in the middle, and the other at the end, and all the branches are yellow. And on the first day of the moon each branch has one azure leaf, and on the second day of the moon two little azure leaves like *Turonensis grossa* or *Turonensis parva*. And so the leaves multiply until the fifteenth day, and afterwards one leaf falls off every day. Moreover, of the juice of its leaves if anyone drinks a dram, I have found that though a man be a hundred, he would return to the condition of thirty years."

After quoting three lines from the Salernitan Tables as to *Memith*, RUFINUS adds that he has found such disagreement concerning this herb that it leaves him in great doubt. AVICENNA says that it is *celidonia* which is hot in the fourth degree. And the Tables of Salerno say that *Memith* is cold in the second degree. " But it should be known that I, RUFINUS, have heard from a physician that the herb exists in great quantity in the sand of Rapallo and resembles black pepper in leaves and stems but is quite different in its flower. For whereas the flower of black

pepper is very delicate in its petals and is quite red, the flower of this herb called *Memith* is yellow of a wonderful hue. And this *Memith* has very delicate *theucas* (?) like those of *Fenugrecus*. The root of this herb is used in eye washes. Also the ninth Table of Salerno says that *Memith* is the same as *Celidonia agrestis*."

" *Millefolium* is called by other names : *Ambrosia* and Venus's eyebrow or also *Centonium*. It has a somewhat long stalk, its leaves are very minute like fennel or *Abrotanum*, its flower is white in a round crown like *Pastinaca*. We use its leaves. For its flowers kill worms because of their bitterness. Some of its flowers are white, some yellow, and some purple, and they are all in round crowns on the top of little branches like fennel seed."

" *Mirasolem* is the same as garden guard, *Pentadactilus*, *Girasolem*, and is an herb which has a high stalk like *atriplex* and seems almost a tree. Its leaves are round, reddish, and intercised as leaves of the vine or as the leaves of *Pes collumbinus* are intercised. It has a purple stem and very thick. Its seeds seem like the worms which in summer cling to dogs and beasts and are the size of beans and are commonly called *Resne* and can scarcely be pulled off the beasts. The leaves on its stem are large—as much as a span. It has a purple flower." None of these last three herbs is included by ALBERTUS.

" *Satyrion* by another name is called Patricide *(interfector patris sui)*. There are two kinds, the larger and smaller. *Maior satyrion* has on its root two testicles, one long and dry, the other green. It has broad leaves like *Plantago lanceolata* and has a ferule and on top it has flowers between white and purple. *Minor satyrion* is also called fox's testicles. It has a small ferule, long narrow leaves like the fingers of one's hand. Its flowers are pure and purple and are very azure. If the dry testicle was of the past year and the green of the present year, the dry one of the past year eaten or drunk in wine or spiced water extinguishes lust wonderfully, while the green one excites to sexual intercourse." ALBERTUS under *Satyrion* has simply a cross reference to *Apium silvestre* of which his discussion is quite different.

RUFINUS was not merely a student of herbs but a medical practitioner as a long passage in connection with the herb, *Paritaria*, shows. " A certain man who for twenty eight days had been in such pain near the right breast that he could scarcely speak

came to me and said that he had been suffering intolerable pain in the breast, and he placed his hand on the right side, and immediately I understood that it was the apostema called *peripleumona* which develops in the lung. And since the pain was partly before and partly behind, I had made for him two bags of woven material filled with fine *paritaria*, removing the stems, and with absinth and bran." RUFINUS had the bags boiled in water and white wine, and, after they had come to a boil three or four times, they were twisted tight and bound with butter and *dialtia* (?), one on the chest and the other on the back of the patient where he felt the pain. This process of heating in water and wine and anointing was repeated daily and twice at night until, after the fourteenth day or application, a big globule of humor began to appear where the bag had been placed on the patient's back. RUFINUS then made "a noble plaster" of cooked mallow root, meal of *fenugrecus*, linseed, yolks of hard boiled eggs, and butter. This was superimposed hot on a piece of cloth on the bubble of humor many times. "And as the apostema came to a head, I told the patient's brother to bring a barber who lanced the apostema and squeezed it out hard. And since the patient was poor he feared expense and made a spout of cane and stuck it on the head of the apostema, and pus came out with putrid blood to nearly the quantity of a large *senaverium* (?). And so he repeated putting the said plaster on thrice every day, and he was completely cured with such treatment and the said plaster in thirty-two days. And the sick man himself told me that the pus expelled from the said apostema amounted to a barrel and a half, yet he neither drank wine nor ate fat until he was fully cured and because he carefully observed the diet prescribed for him, all went well."

"Likewise for one who could not urinate I had made a bag of *Paritaria* and *Abrotanum* boiled in white wine, and it was put as hot as he could bear it on the thigh, and another bag similarly hot under the testicles between both buttocks near the point where the urine passes to the bladder, with the result that he who had been unable to urinate for three days voided four urinals full of urine between the third hour of the day and vespers. And so he who was almost dead by God's aid and the benefit of *Paritaria* and *Abrotanum* was completely cured."

" Moreover, I, RUFINUS, declare with God as witness that in 1287 from the Passover to the first of September with the aforesaid bags of *paritaria* and absinth and bran, doing as above stated and afterwards putting a maturative plaster on the painful spot as described, more than sixty-five men and women were cured in the aforesaid time. Some who had an apostema in the breast spit blood and pus from the mouth during the day. Others who had it in the intestines voided two basins of blood and pus on the stool. In other cases of apostemata in the spleen or lung, the *paritaria* which is *diaforetica* with absinth and bran made the said apostemata appear externally, and these were opened and they were cured. And in that year this type of infirmity was more common in women than men."

Some eight pages of RUFINUS' work are devoted to unguents, one of which gives us another glimpse of his medical practice. A patient had a badly swollen thigh, red and inflated, " and all the surgeons who saw the said thigh wished to cut into it." But RUFINUS forbade their doing so and cured the patient in three days with an ointment made of marble pulverized and mixed with honey. " And I proved this in many men and women."

Or RUFINUS recalls a case of another Italian medical practitioner. " Master MATTHEW OF GENOA gave RAYMUNDINUS CYDADA goat's milk to drink to move his bowels, and straightway two hours later he died. The leading physicians called into consultation said that the goat who gave the milk had eaten poisonous herbs. The same thing happened to NICHOLAS DE VOCTA in Genoa."

As his use of marble has suggested, RUFINUS' work is not exclusively limited to herbs and botany. He has chapters on bitumen and cement, telling how either is made, and a chapter on *Minium* stating its manufacture from lead. Eggs, the bone from the heart of a deer, salt, pearls, and tyriac are the themes of other chapters more medical or chemical than botanical. There even is a chapter on the wheel in which reference is made to the instrument called *sexta*, i.e. the sextant, and to the astrolabe, and to PTOLEMY's proving by it and the polar star that the circumference of the earth is 20,400 miles. (5)

---

(5) In the chapter, " Rota," Ashburnham 189, fol. 95*v*, vol. 2, the figures go on confusedly : " probat THOLOMEUS quod circumferentia maris et terre est

Indeed, although writing primarily on herbs, RUFINUS cannot forget his earlier astronomical studies, as his chapters on Virtue and on the Zodiac bear further witness. In them he outlines the astronomical system of PTOLEMY and ALFRAGANUS and states that only one quarter of the earth's surface is dry land. But his botanical interest also appears in the chapter on virtue when he notes that God and the incorruptible stars have put in herbs and trees so many and so great virtues through the corruptible and contrary qualities found in them that human sense fails in contemplating them. For we see a great tree like a tower grow from a single little nut, " nay from only the very top of the fruit where there is a grain like a grain of wheat, and that grain has many coverings and in the midst of them is a point well nigh invisible whence the tree issues and grows."

Our quotations from RUFINUS have already indicated that he shared the medical superstitions of his day and the belief in marvelous occult properties and sympathetic magic, as when a root that looked like testicles was used as an aphrodisiac and anti-aphrodisiac. He had heard at Bologna from sages and herbalists that if a goat were fed for twenty-five days on the herb called eye of the sun or eye of Christ, its blood dried and used in food and drink would break and remove the stone in bladder or kidneys. But such notions are what we expect to find in ancient, medieval, and even early modern works. The belief in the power of goat's blood to break the stone and even adamant was of hallowed antiquity. ALBERTUS MAGNUS is equally credulous and, to our way of thinking, superstitious in his *De vegetabilibus et plantis*.

Such features of RUFINUS' work do not detract in the least from his careful, discriminating descriptions of the herbs themselves, of which we have reproduced here only a fraction by way of illustration and in which he seems superior to even ALBERTUS MAGNUS. RUFINUS also makes it fairly evident that this sort of botanical interest and knowledge was not peculiar to himself but was shared in to a considerable degree at least by the Italian

---

viginti milia miliaria et quadraginta quinque milia nonagintaquinque miliaria," but at fol. 109r, col. 2, in the chapter, " Virtus," the distance is again given as 20,400 miles.

herbalists of his time. His independence and ignorance of ALBERTUS MAGNUS' *De vegetabilibus et plantis*, though he writes after 1287, also affords food for thought. ALBERT of course taught at Paris and Cologne, while RUFINUS studied at Naples and Bologna. But men and books both crossed the Alps with frequence and freedom in those days. However, we seem to have evidence of local study and knowledge of botany which may have been far more widespread and healthy than we think; and it even appears, shocking as this may be to those who have viewed medieval science as purely scholastic, that personal observation and experience sometimes exerted more influence than the literary tradition. RUFINUS does not know the *De vegetabilibus* but he knows plants, and that is a great deal better. Moreover, he professes only to give us a digest of seven previous authorities but he actually presents us with a wealth of personal observation of nature and clinical experience.

This being the case, why has this original and meritorious work of RUFINUS remained unread, unprinted, and neglected through the centuries, while corruptions of DIOSCORIDES and PSEUDO-APULEIUSES and MACERS have been multiplied and studied? Here would seem to be neither a survival of the fittest nor substantiation of the theory of modern progress. The answer may be partly that the world does not care much for originality or for precise detailed information, and that most historical investigators are prone to follow in one another's footsteps like sheep. Such human characteristics were especially marked during the period of Italian humanism or the so-called Renaissance with its dislike and disregard for much preceding medieval achievement and its harking back to the classical period as the fount of culture and learning. During this essentially retrograde movement, at least in the sphere of science, RUFINUS who had committed the additional crime of not using PLINY was probably shelved and forgotten. The early printers found a much larger sale for the little *Secrets* of ALBERTUS on herbs than for the *De vegetabilibus* to say nothing of RUFINUS. When a few quaint and crochety early moderns began to botanize, they were apt to forget even ALBERTUS or to treat him as exceptional and to represent themselves as the first since the ancients really to observe plants. But all we have to do is look about in the manuscripts, and the ghost of RUFINUS

himself rises to confront and confute them. Medieval art and story, medicine and surgery, have already been resuscitated and rescued from such aspersions. If we look a little further, we shall probably find a RUFINUS in nearly every field of human interest and endeavor. Why not? "Before your Agamemnons there were men."

Columbia University
New York City. LYNN THORNDIKE.

Robert Boyle and his Influence on Thought in the Seventeenth Century (*)

I

Toward the end of the 19th century Science had begun to exert a profound influence upon the life and thought of all civilized races. DARWIN had shaken the foundations of orthodox religious faith, and the discoveries of GALVANI, VOLTA and FARADAY were presently to transform the conditions of man's existence on the earth. Since then the forces of Nature have been placed under control on a vast scale, the full extent of which was not understood until the advent of the Great War. In addition to material increase in power—be it for good or for evil—there has been a nobler and more far-reaching effect of Science upon the beliefs and actions of mankind; and it is to this phase of the relation between Science and History that I now invite your attention. In recent years scientists have grown self-conscious, perhaps because they have only lately become of age. They realize that they are now a part of the drama of human history, and they look to the professional historian for background and perspective. If in return they can offer anything that will allow him to interpret present-day trends with greater clarity and with more prescience as to the future, they will feel gratified—and happy that a great debt is in part repaid.

To gain an insight into the relation between Science and History we must study our origins and attempt to trace the events which led to Science becoming an integral part of the intellectual equipment of educated men. This is a phase of the development of human culture usually neglected by general historians and

(*) Read December 30, 1931, at a joint meeting of the History of Science Society and the American Historical Association, Minneapolis, Minnesota.

little appreciated by scientific historians because of the great difficulty in obtaining a complete picture of a civilization in any given period. MACAULAY, for example, gives only passing mention to the intellectual revolution that occurred after the Restoration through the activity of men such as BOYLE and HOOKE and NEWTON. (1) Mr. H. G. WELLS (2), more recently, has attempted to portray human history without mention of a physician and with scant reference to the achievements of other scientific men. I am aware that MACAULAY and Mr. WELLS do not, perhaps, fall into the category of professional historians, but I submit that any attempt to depict the march of human events which leaves out scientific and philosophical movements is incomplete and inadequate.

The present paper will recount some of the circumstances which led to the remarkable advancement of Science in the 17th century and to its influence upon the thought of that period, and I propose to weave the story about the name of ROBERT BOYLE, for I believe that BOYLE did as much, and perhaps more, to establish Science as an integral part of the intellectual life of ordinary men as any of his predecessors or contemporaries. He was, moreover, a pioneer and his life and his work therefore merit our closest attention and study.

BOYLE was a child of his time, favored by Fortune and blessed with an industrious nature. In the course of his life he published forty-two books and as many scientific papers, but the weaknesses of his age were as much a part of his character as its virtues. He combined Theology and Science; he recommended impossible nostrums and quack remedies for the ailments to which the flesh is heir; and he believed in the transmutation of gold into the baser metals. And yet it was perhaps these very foibles of his scientific career that made him intelligible and appealing to men in the ranks. NEWTON, his contemporary, lived in an airy sphere which few could penetrate—he wrote in Latin and was indifferent to praise. BOYLE, to be sure, walked humbly, but he spoke and wrote a language that uneducated men could

(1) MACAULAY, T. B. *History of England from the Accession of James II*, London, LONGMANS, 1848-55. MACAULAY mentions NEWTON several times but the names of BOYLE and HOOKE do not occur.

(2) WELLS, H. G. *The Outline of History*, London, 1923.

read and understand, and this accounts in large measure for the influence he exerted.

Before describing BOYLE's career we may allude briefly to the events which led to the scientific renaissance of the 17th century.

II

In ancient times study of the secrets of Nature had little influence upon philosophy, or upon affairs of state. PLATO and SOCRATES were content to contemplate the universe subjectively, and it is difficult to persuade oneself that ARISTOTLE's ethics or his other philosophical conceptions were greatly influenced by his intimate knowledge of natural phenomena. This of course is a debatable point, and it should be regarded as an expression of a tendency rather than as a final judgment concerning ARISTOTLE's contribution. The change in outlook might have come in the 2nd century of the Christian era when GALEN, the private physician of MARCUS AURELIUS, began to investigate the functions of living organisms. He was the first to pursue the experimental method in Science on an extensive scale but he did not transform Man's attitude toward the universe because of his 'time'—which he failed to ripen—and because as a philosopher he was at best mediocre.

The real change in point of view came at a much later period in history. The intellectual ferment of the early Renaissance culminated in the year 1543, when VESALIUS and COPERNICUS brought forth their epoch-making books. After November 1543 the earth was no longer a flat center of the universe, but a sphere as COLUMBUS had thought—one of many revolving about the sun. Mankind was slow to accept the new truths for COPERNICUS's book was written in Latin and few were equipped to comprehend its tables and mathematical symbols. It bore the title, *De Revolutionibus Orbium Coelestium* and it caused the greatest revolution that has ever occurred in Man's attitude toward the universe. The Roman Church, however, was so completely committed to the Ptolemaic system that the book was placed immediately on the *Index* (3) (by the Pope to whom it was dedicated), and it

(3) The first *Index Librorum Prohibitorum* of the Roman Church was drawn up between 1543 and 1546 by Pope PAUL III, to whom COPERNICUS had dedicated

was not removed until the year 1822! A copy of the book recently acquired by the Yale University Library (4) has many of the heretical passages crossed out in contemporary ink, evidently by the hand of some 16th-century ecclesiastic.

VESALIUS's book, which also appeared in 1543, exerted a wide influence but it was less far-reaching in respect of philosophical conceptions. As a monument of human industry there are few parallels to the *De Humani Corporis Fabrica*, a glorious folio published when its author was 28 years of age. It contains a faithful record of the structure of the human body but, as Professor SIGERIST has pointed out, its point of view was essentially 'static' and the real change in biological philosophy came, not with VESALIUS but at a later date, with the discoveries of WILLIAM HARVEY. The new idea of movement and action for which HARVEY stood has lately been symbolized by Professor SIGERIST (5) in his use, somewhat alarming at first thought, of the word "baroque". The point of view of VESALIUS and of HARVEY's master, FABRICIUS, was static and could be symbolized by straight lines. The philosophy of HARVEY was one of movement and curves—" baroque "—and out of it came the great discovery of the motion of blood in a circle. Men then began to consider other problems of functional activity: respiration, muscular contraction, the reflex movements of decapitated insects, and a hundred other problems that would not have suggested themselves had not a new outlook been forced on the human mind.

HARVEY was born in 1578; his announcement of the discovery of the circulation was made orally in 1615 but his book was not published until 1628; he died in 1657. FRANCIS BACON had meanwhile become an ardent exponent of the experimental

---

his book. Before that time local indexes had been published in various countries but they did not have the official sanction of the Papacy. The first index published by the Papacy was issued by PAUL IV in 1559 and bears the title *Index auctorum et librorum, qui ab Officio Sanctae Rom. et Universalis Inquisitionis caveri ab omnibus.* (Reusch, Fr. Heinrich. *Die Indices Librorum Prohibitorum des sechzehnten Jahrhunderts*, Tübingen, Litterarischer Verein in Stuttgart, 1886, 598 pp. *Index der verbotenen Bücher*, 2 vols., Bonn, MAX COHEN & Sohn, 1883-85, 624 + 1266 pp.)

(4) Obtained from Professor J. S. TURNER of Iowa State College, Ames, Iowa. It had appeared in *Sotheran's Price Current of Literature*, No. 828, 1931.

(5) Lectures at the Institute of the History of Medicine, Johns Hopkins University, November 5, 1931. To be published by The Johns Hopkins Press.

method (6) and had foreseen the need of a scientific academy. As an appendix to the second edition of *Sylva Sylvarum* which appeared in 1628, two years after BACON's death, RAWLEY, his editor, issued his *New Atlantis*. The need for an organized scientific institution is here for the first time set forth, and the further point is emphasized that scientists require, above all things, collaboration and protection. The universities are not referred to in the *New Atlantis* and the idea that Science might develop within their walls had apparently not passed through VERULAM's mind. From these beginnings modern scientific institutions arose, for the Royal Society, which was incorporated in 1662, was admittedly founded on BACON's great conception. Unwittingly the Lord Chancellor of England had begotten a new and protesting offspring whose lusty voice was ultimately to be heard to the ends of the earth.

One may smile at the conservatism of the Church of Rome in refusing to accept the Copernican system until 1822 when it was forced upon it by the subsequent discoveries of TYCHO BRAHE, KEPLER, NEWTON, LAPLACE, and the HERSCHELS; but this conservatism is not to be compared with the arrogance of the chief centers of learning with regard to Science as a whole. With a few brilliant exceptions, chiefly among the Dutch universities, the heavy hand of classical tradition persisted without essential modification until the late 18th cenrury. Most administrative offices were held by theologians and all instruction was in Latin. The Bachelor's degree was granted on completion of a four years' course, involving study of grammar, logic, rhetoric, arithmetic, geometry, and astronomy. The astronomy was Ptolemaic, the mathematics Euclidian, and the logic entirely Aristotelian. If one proceeded to a higher degree, *e.g.* in medicine, before the end of the 17th century, knowledge of GALEN and HIPPOCRATES was all that was required, and four to seven years were spent in obtaining the degree. Outside the medical faculty the textbooks were mainly Aristotelian. Didactic lectures were given, and in addition to attending these students defended their theses at public disputation. " These disputations were never supposed to bring in new subject matter; they were only to give the student

(6) BACON, F. *Two Books of the Advancement of Learning*, London, 1605.

a chance of combining and recombining, ot practising and exercising, what he had acquired from Aristotle or other authorities. This feeling of the finality and sufficiency of what had been discovered by the standard Greek writers was at once the most characteristic and most pernicious feature of the system. At these disputations the professor presided, and saw that the arguments proceeded along the strict lines laid down by Aristotle's logic." (7)

In tracing the history of the experimental method I pointed out a year ago (8) that the great scientific societies such as the Accademia del Cimento, the Leopold Academy, and the Royal Society came into being largely because the universities refused to admit Science within their walls. This spirit of intolerance has in fact died almost as hard as the Papal *Index*, for we must remember that the acceptance of Science by the universities has occurred largely within the last 50 years. The Renaissance in university life which followed the appearance of strong scientific faculties is scarcely to be regarded as a coincidence.

It is a fact of peculiar significance, therefore, that the centers of learning of the 17th century had little to do with the fostering of Science, and this is particularly well exemplified by the career of ROBERT BOYLE.

III

A few weeks before his death BOYLE published one of his less important scientific treatises, in the preface of which he

(7) ORNSTEIN, M. *The Rôle of Scientific Societies in the Seventeenth Century*, Columbia Ph. D. thesis, published privately, New York, 1913 (Reprinted, University of Chicago Press, 1928), 248-49. After this passage Miss ORNSTEIN cites the following passage from ACQUAVIVA, the Jesuits' *Ratio Studiorum*, as illustrating the spirit of the universities in the 17th Century : " The teacher is not to permit any novel opinions or discussions to be mooted; nor to cite or allow others to cite the opinions of an author not of known repute; nor to teach or suffer to be taught anything contrary to prevalent opinions of acknowledged doctors current in the schools. Obsolete and false opinions are not to be mentioned at all even for refutation nor are objections to received teaching to be dwelt on at any length... In philosophy Aristotle is always to be followed and St. Thomas Aquinas generally..."

(8) FULTON, J. F. " The Rise of the Experimental Method," *Yale Journal of Biology and Medicine*, 1932, *iii*, 299-320.

expresses the hope that his observations, " may be taken in good part from a Person... that was never a Professor of Philosophy, nor so much as a Gown-man." (9) This, I believe, gives the keynote of BOYLE's career. He never assumed the responsibilities of a university position, probably because the atmosphere was not congenial and he preferred his independence. Furthermore, though he was created " Doctor of Physick " at Oxford in 1665, he was never a student at any university and obtained his education entirely from tutors and travels.

The seventh son and fourteenth child of RICHARD BOYLE, first Earl of Cork, ROBERT BOYLE was born at Lismore, County Cork in Ireland, on January 25th, 1627. His father had gone to Ireland in 1588 as a clerk in the service of Queen ELIZABETH, and within ten years he had become the most wealthy and powerful landholder in Ireland. His mother was a kindly but not brilliant woman who died shortly after ROBERT's birth through complications incident to bringing her fifteenth child into the world. BOYLE's brothers and sisters inherited his father's shrewdness and some of his brothers had also that strain of unscrupulousness which must have played some part in the rapid growth of his father's fortunes. (10) ROBERT himself seems to have inherited his industry and his alertness of mind. His other traits of character began to appear during his years at Eton and it would be unwise to attribute them either to nature or nurture. Sir HENRY WOTTON, the provost of Eton, was quick to recognize that ROBERT was an unusual student and he soon placed him in the hands of a judicious and far-seeing tutor named MARCOMBES. With him ROBERT travelled on the Continent and added to his careful grounding in classical tongues a thorough familiarity with French, German, and Italian.

On returning from the Continent BOYLE stayed with his sister, Lady RANELAGH, in London, retiring from time to time to his

---

(9) BOYLE, R. *Experimenta et Observationes Physicae*, London, 1691, f. A7*b*. In *The Excellency of Theology*, published in 1674, he remarked similarly, " I am no lecturer or professor of physics." (f. A5*a*.)

(10) The publication of the *Lismore Papers* in 1911 (edited by Rev. ALEX GROSART, 10 vols.), in which the EARL OF CORK's remarkable diary was for the first time made available, has done much to dispel the incredulity and suspicions of doubtful integrity which had long existed concerning him.

country estate at Stalbridge in Dorset, and he soon found himself the center of an active group who, after 1645, began to meet together from time to time with a view to discussing scientific problems and to " increasing natural knowledge by means of experiment ". They referred to themselves as the " Invisible College." The story of how this group later moved to Oxford and later still returned to London, to become incorporated in 1662 as the Royal Society of London, has been frequently told and need not be repeated here. That BOYLE, even before the age of twenty, was a moving spirit in the group is clear from an abundance of contemporary evidence. (11) His name is invariably mentioned in the early descriptions of the " Invisible

(11) The first direct reference to the " Invisible College " that has come down to us occurs in a letter of BOYLE to MARCOMBES written from London, October 22, 1646. The letter is long and gives a most interesting account of the political troubles of the day. At the end is the following remarkable paragraph : " The other humane studies I apply myself to, are natural philosophy, the mechanics, and husbandry, according to the principles of our new philosophical college, that values no knowledge, but as it hath a tendency to use. And therefore I shall make it one of my suits to you, that you would take the pains to enquire a little more thoroughly into the ways of husbandry, &c. practised in your parts; and when you intend for *England*, to bring along with you what good receipts or choice books of any of these subjects you can procure; which will make you extremely welcome to our *invisible college*, which I had now designed to give you a description of."

Several months later in a letter also from London, dated February 1646-7, to Mr. FRANCIS TALLENTS, a fellow of Magdalene College, he says : " The best on't is, that the corner-stones of the *invisible*, or (as they term themselves) the *philosophical college*, do now and then honour me with their company, which makes me as sorry for those pressing occasions, that urge my departure, as I am at other times angry with that solicitous idleness, that I am necessitated to during my stay."

There is a third reference to the " Invisible College " at this time in a letter of May 7th, 1647 addressed to SAMUEL HARTLIB, MILTON's close friend : " Besides this, I say, you interest yourself so much in the *Invisible College*, and that whole society is so highly concerned in all the accidents of your life, that you can send me no intelligence of your own affairs, that does not (at least relationally) assume the nature of *Utopian*." (BIRCH, THOMAS. *The Works of the Honourable Robert Boyle in Five Volumes. To which is prefixed The Life of the Author*, 1st ed., London, A. MILLAR, 1744, *i*, 20, 24.

The paragraph from the letter to MARCOMBES indicates that the " Invisible College " had been in existence for some time and that apparently BOYLE had been regularly attending their meetings. His statement of its aim (*i.e.*, that it values no knowledge, but as it hath a tendency to use) is an inadequate statement of their ultimate objectives as set forth later in *The Usefulness of Experimental Philosophy*.

College." In 1651, when BOYLE was only twenty-three, we find NATHANIEL HIGHMORE seeking his patronage by dedicating his book *The History of Generation*, " to the Honourable, Mr. ROBERT BOYLE, son to the Right Honourable the late Earl of CORK... Being ravisht, Sir," HIGHMORE says, " with these considerations of your worth and candor, I shall not fear to throw these Papers into the bosom of your protection; from whom as I cannot misse a judicious censure, so I shall hope for a candid reception."

By 1651 BOYLE had already begun to try his hand at writing but he had published nothing. *Seraphick Love* and *A Discourse against Swearing* were already in manuscript and *The Usefulness of Experimental Philosophy*, which was published in 1663, in which he sets himself down as an ardent protagonist of the experimental method, was written about 1650, for he says in the ' Author's Advertisement ' that the first part of the book was written " 10 or 12 years ago (when I was scarce above 21 or 22 years old). " This is important since it means that BOYLE had been preaching the gospel of experiment long before the Royal Society was founded.

After a trip to Ireland in 1653 BOYLE returned to England and in June 1654 he went to reside in Oxford. There he could live relatively undisturbed by the political distractions of the time and he was able to enjoy the society of a few friends who were particularly congenial, several of whom had been among the " Invisibles " in London. Among them were CHRISTOPHER WREN, who at that time was interested in mathematics and astronomy; JOHN WALLIS, the geometer, SETH WARD, the Savilian professor of astronomy, and THOMAS WILLIS, the physician. In this friendly atmosphere BOYLE was able to indulge his taste for reading and to continue his chemical experiments. He did not join a college and it does not appear that he frequented the colleges apart from occasional meetings at Wadham.

In 1658 BOYLE secured the services of an impecunious student chorister of Christ Church bearing the name of ROBERT HOOKE, who materially assisted him in constructing an air pump. With this instrument BOYLE began the memorable series of investigations which, in 1660, led to the publication of his first scientific book, *The Spring and Weight of the Air*, and in 1662 to the formulation of the celebrated gas law that still bears his name.

Before describing BOYLE's contributions to Science, it will be illuminating to dwell for a moment upon his habits of writing and publishing.

IV

BOYLE's career as a writer began in 1659 with the publication of a devotional tract, a *pièce de jeunesse*, written many years before and entitled *Some Motives and Incentives to the Love of God*, better known as *Seraphick Love*, and it ended in 1695 with a posthumous publication, *A Free Discourse Against Swearing*, also one of BOYLE's juvenilia, making a total of forty-two books which had come from his prolific pen. Many of them had passed into successive editions, continuations, and even added volumes. Of the forty-two titles thirty are scientific treatises and, with the exception of the tract advertising the loss of his writings, the remainder are either theological tracts or philosophical dialogues. His theological writings do not concern us. The scientific works are difficult to classify since in nearly every one he included important observations on physics, chemistry, physiology, and medicine. In addition to his separately published treatises there were thirty-five papers contributed to the *Philosophical Transactions* of the Royal Society. In preparing a bibliography of the works of BOYLE (12) I have recently had occasion to peruse carefully and to compare all of the original editions of BOYLE's various books. They form a particularly interesting chapter in the history of 17th-century book-making and have thrown significant light upon the practices of 17th-century printers and authors. BOYLE himself was a very untidy writer. His ' copy ' was often illegible and he was given to after-thoughts which were pitch-forked into the body of a book after it had been set up in page form. This meant insertions, displacement of signatures, mispagination, and the bewilderment of binders. Many of BOYLE's works are in consequence gathered erratically and are often incomplete.

In the broad field of Science there was little that he did not touch, " and almost every branch of modern Science can trace

(12) FULTON, J. F. " A Bibliography of the Honourable Robert Boyle," *Proc. Oxf. Bibliog. Soc.*, 1932, *iii*, pp. 1-160.

phases of its origin in his writings... weighing the air, the thermometer, the barometer, freezing mixtures, the gas laws, the definition of chemical elements, phosphorus, phosphorescence, electricity, all these things are intimately associated with his name." (13) Since it will be impossible to deal with all phases of BOYLE's scientific career I propose to restrict my remarks to two themes which he studied throughout his active life : the nature of combustion and respiration, and his beliefs concerning the atomic structure of matter, particularly the gases.

V

RESPIRATION AND COMBUSTION

Many hold that the history of a science should consist in the record of the development of ideas without reference to the lives of the men who created them. This, the dispassionate approach of many modern scholars, has been applied to Philosophy and to certain branches of Science, but I cannot believe that it represents history in the fullest sense of the term. Once an idea is separated from its creator it becomes impossible to see either one clearly; moreover, many believe that the way a man lived and worked is more revealing and stimulating to those of a later age than what he did. This is particularly true of the development of ideas concerning respiration and combustion, for here our final judgment is to a large extent colored by knowledge of the personalities involved : *e.g.*, the iconoclastic PARACELSUS, the irascible HOOKE, MAYOW the dreamer, the fastidious LOWER, and BOYLE.

Professor T. S. PATTERSON of Glasgow has recently published a paper (14) bearing on the subject, that has made all historians

(13) *Ibid.*, p. 5.

(14) PATTERSON, T. S. " John Mayow in Contemporary Setting : A Contribution to the History of Respiration and Combustion," *Isis*, 1931, *xv*, 47-96; 504-546. His conclusion may be quoted here : " MAYOW was not the *first* to show that a candle enclosed in a flask goes out while there is still, apparently, abundance of air; he was not the *first* to infer that air is heretogeneous; he was not the *first* to suggest the existence in air of a vital substance also to be found in nitre and nitric acid; he was not the *first* to call this substance nitro-aerial spirit; he was

of Science catch their breath. JOHN MAYOW, an obscure physiologist of Oxford, probably born in 1643, has been proclaimed in all histories of chemistry and physiology as the one who had first enunciated the modern theory of respiration and combustion, namely that the air contributes a substance essential to both processes. Professor PATTERSON has marshalled a devastating number of passages from distinguished historians of Science indicating clearly that no one of them had examined their sources critically and that, in point of fact, MAYOW's ideas were not original but had been borrowed largely from the observations and conclusions of ROBERT BOYLE, published eight and fourteen years previously.

Professor PATTERSON has in my opinion proved his point beyond any shadow of doubt. It is not commonly known that BOYLE dealt with respiration and combustion as early as 1660 in his first scientific work, *The Spring and Weight of the Air*, historians having generally associated this work solely with his discovery of the gas law. In addition to weighing the air BOYLE here dscribed the generation of " air " from the action of aqua fortis on iron filings. Then, in a remarkable chapter entitled " A digression containing some doubts touching respiration " (which deserves some time to be reprinted in full) he showed that birds and mice die within 30 seconds to a minute of the time that air is removed from a receiver by means of an air pump. When

---

by no means the *first* to show that gun-powder can burn without the assistance of air; he was not the *first* to prove—if he made the experiment at all—that the calx of a metal was heavier than the metal; he was not the *first* to show that an animal placed in a closed vessel died more quickly if a lighted candle was also placed in the vessel. It was not MAYOW who *first* suggested that animals exhaust the air of some constituent necessary to life which enters the blood in breathing; and he was not the *first* to infer that this part of the air was the nitro-aerial spirit, and if he was not the first to show or suggest these things, why should he be credited with them? Moreover, he said nothing about combustion in 1669. The only statement which is *partially* correct is that MAYOW attributed the increase of weight on calcination of antimony—he did not extend the suggestion to other metals—to combination with igneo-aerial particles, but, as has been shown above, §§ 78, 127, this was merely the adoption of a notion already published by BOYLE, and, in addition, since MAYOW's idea of nitro-aerial spirit was very different indeed from our notion of oxygen, it could lead neither MAYOW nor his contemporaries any way towards a comprehension of combustion and respiration. Therefore it was ignored, and quite rightly so. MAYOW's so-called ' discovery of oxygen ' (see §§ 10, 16, 18, 19) was not forgotten; it was never made." (p. 538).

allowed to remain in the same receiver sealed tight but not exhausted of its air, the animals may live on for 30 to 40 minutes. To cite his own picturesque description : " Another Bird being within about half a minute, cast into violent Convulsions, and reduc'd into a sprawling condition, upon the Exsuction of the Air, by the pitty of some Fair Lady's (related to Your Lordship) who made me hastily let in some Air at the Stop-cock, the gasping Animal was presently recover'd, and in a condition to enjoy the benefit of the Lady's Compassion. And another time also, being resolv'd not to be interrupted in our Experiment, we did, at night, shut up a Bird in one of our small Receivers, and observ'd, that for a good while he so little felt the alteration of the Air, that he fell asleep with his head under his wing; and though he afterwards awak'd sick, yet he continu'd upon his legs between forty minutes and three quarters of an hour; after which, seeming ready to expire, we took him out, and soon found him able to make use of the liberty we gave him for a compensation of his sufferings." (15)

Then BOYLE pertinently remarks : " Perhaps... there is some use of the Air which we do not yet so well understand, that makes it so continually needful to the Life of Animals. *Paracelsus* indeed tells us, *That as the Stomack concocts Meat, and makes part of it useful to the Body, rejecting the other part, so the Lungs consume part of the Air, and proscribes the rest.* So that according to our Hermetick Philosopher ... we may suppose, that there is in the Air a little vital Quintessence... which serves to the refreshment and restauration of our vital Spirits, for which use the grosser and incomparably greater part of the Air being unserviceable, it need not seem strange that an Animal stands in need of almost incessantly drawing in fresh Air. But though this opinion is not... absur'd,... it should not be barely asserted but explicated and prov'd." (16)

(15) BOYLE, R. *Spring and Weight of the Air*, London, 1660, p. 361.

(16) *Ibid.*, p. 362. I cannot refrain from citing here one further passage which contains a remarkable forecast concerning the nature of mountain sickness : " That (on the other side) an Air too much dilated is not serviceable for the ends of Respiration, the hasty death of the Animal we kill'd in our exhausted Receiver, seems sufficiently to manifest. And it may not irrationally be doubted, whether or no, if a Man were rais'd to the very top of the Atmosphere, he would be able to live many minutes, and would not quickly dye for want of such Air as we are

In the second edition of *The Spring and Weight of the Air* BOYLE again discusses respiration and combustion but remarks that he could not reach more definite conclusions until he had examined the matter more deliberately. This he did not do until 1674, the year in which MAYOW published his *Tractatus Quinque*. MAYOW had meanwhile published his tract on respiration in 1668 (17) in which a careful summary is given of BOYLE's work and the work of LOWER, HOOKE and others who had written between 1660 and 1668. I entirely concur in Professor PATTERSON's statement that there was nothing original in MAYOW's treatise and that the new ideas it expresses were wrong.

BOYLE's *Suspicions about some Hidden Qualities in the Air*, which appeared in 1674, gives his considered opinion concerning the nature of combustion. Professor PATTERSON does not quote from this remarkable tract, and had he been familiar with it, I feel sure that he would have been even more convinced that BOYLE,

---

wont to breath here below. And that this Conjecture may not appear extravagant, I shall on this occasion subjoyn a memorable Relation that I have met with in the Learned *Josephus Acosta*, who tells us, That when he himself past the high Mountains of *Peru*, (which they call *Pariaecaca*) to which, he says, That the Alps themselves seem'd to them but as ordinary Houses, in regard of high Towers, he and his Companions were surprised with such extream Pangs of Straining and Vomiting, (not without casting up Blood too) and with so violent a Distemper, that he concludes he should undoubtedly have dyed, but that this lasted not above three or four hours, before they came into a more convenient and natural temperature of Air : To which our Learned Author addes an Inference, which being the principal thing I design'd in mentioning, the Narrative I shall set down in his own Words : *I therefore* (says he) *perswade myself, That the Element of the Air is there so subtle and delicate, as it is not proportionable with the breathing of Man, which requires a more gross and temperate Air; and I believe it is the cause that doth so much alter the Stomack, and trouble all the Disposition.* Thus far our Author, whose Words I mention, that we may ghess by what happens somewhat near the Confines of the Atmosphere (though probably far from the surface of it) what would happen beyond the Atmosphere. That which some of those that treat of the height of Mountains, relate out of *Aristotle*, namely, That those that ascend to the top of the Mountain *Olympus*, could not keep themselves alive, without carrying with them wet Spunges, by whose assistance they could respire in that Air, otherwise too thin for Respiration : (That Relation (I say) concerning this Mountain) would much confirm what has been newly recited out of *Acosta*, if we had sufficient reason to belive it : But, I confess, I am very diffident of the truth of it; partly because when I pass'd the *Alps*, I took notice of no notible change betwixt the consistence of the Air at the top and at the bottom of the Mountain." (pp. 355-58.)

(17) MAYOW, J. *Tractatus duo*, Oxford, 1668.

rather than MAYOW, deserves credit for the modern conception of respiration and combustion. The opening paragraph is typical of what follows : " Besides the four first Qualities of the Air, (Heat, Cold, Dryness and Moisture) that are known even to the Vulgar; and those more unobvious, that Philosophers and Chymists have discovered, such as Gravity, Springiness, the power of Refracting the beams of Light; &c. I have often suspected, that there may be in the Air some yet more latent Qualities or Powers differing enough from all these, and principally due to the Substantial Parts or Ingredients, whereof it consists. And to this conjecture I have been led, partly (though not only or perhaps chiefly) by considering the Constitution of that Air we live and breath in, which, to avoid ambiguities, I elsewhere call *Atmospherical* Air. For this is not, as many imagine, a Simple and Elementary Body, but a confus'd Aggregate of effluviums from such differing Bodies, that, though they all agree in constituting, by their minuteness and various motions, one great mass of Fluid matter, yet perhaps there is scarce a more heterogeneous Body in the world." (18)

After describing observations on the increase in weight of metals on heating in air, one finds the following suggestive passage : " The Difficulty we find of keeping Flame and Fire alive, though but for a little time, without Air, makes me sometimes prone to suspect, that there may be dispers'd through the rest of the Atmosphere some odd substance, either of a Solar, or Astral, or some other exotic, nature, on whose account the Air is so necessary to the subsistence of Flame; which Necessity I have found to be greater, and less dependent upon the *manifest* Attributes of the Air, than Naturalists seem to have observed. For I have found by tryals purposely made, that a small flame of a Lamp, though fed perhaps with a subtil thin Oyl, would in a large capacious glass-Receiver expire, for want of Air, in a far less time than one would believe." (19)

There are many other suggestive passages in this tract and another little-known work of BOYLE entitled *New Experiments touching the relation betwixt Flame and Air*, published in 1672,

(18) BOYLE, R. *Suspicions about Some Hidden Qualities of the Air*, London, 1674.
(19) BOYLE, R. *Ibid.*, p. 24, 25.

which indicate that BOYLE was clearly aware (1) of the heterogeneous character of the air, and (2) that respiration and combustion depended upon the presence in the air of some specific substance which was removed by either process. All of his statements, moreover, are characterized by the caution and reserve of a great scientist. From the facts already before you and from careful study of BOYLE's writings on combustion, it is clear that BOYLE approached the discovery of oxygen more closely than anyone before PRIESTLEY and LAVOISIER.

ATOMIC STRUCTURE AND THE KINETIC THEORY OF THE GASES

Mr. JOSHUA C. GREGORY of Leeds in his new and stimulating book on the history of atomism (20) has given an excellent discussion of the background of BOYLE's atomic theory. BOYLE was familiar with the ancient writers, LEUCIPPUS, DEMOCRITUS, LUCRETIUS and the Epicureans, but of his near contemporaries only GASSENDI and DESCARTES had revived the ancient theory. Since GASSENDI and DESCARTES were not experimentalists, BOYLE must be allowed the credit of having first examined the hypothesis experimentally and of elaborating it in truly scientific fashion—*pour préciser les idées*.

The transition from BOYLE's theories of combustion to his conception of the atom is not difficult to make since he was prone himself to mention them in the same breath. His work on the ' spring of the air ' which we have just discussed led him to consider the ultimate nature of gases and of matter in general, and he indicates clearly in this, his first scientific work, that he was already committed to a modified Cartesian system. His conception is set forth in preliminary form in *The Sceptical Chymist* (1661) and in *Certain Physiological Essays* (1661) but the theory is developed in much greater detail in *The Origine of Formes and Qualities* (1666). GREGORY (21) has remarked that the book is particularly significant in the history of Science because it repre-

(20) GREGORY, J. C. *A Short History of Atomism from Democritus to Bohr*, London, BLACK, 1931.

(21) *Ibid.*, p. 33.

sents, " the invasion of Science by corpuscular expositions through the dominating influence of DESCARTES. As BOYLE adopted his own private version of Cartesianism he expressed the scientific mind of his time in a welcome to the exiled atom that was returning as a corpuscle."

Nowhere in the history of Science can one find a more judicious and telling protest against the dominance of Greek learning than in BOYLE's Proemial Discourse to ' Formes and Qualities.' He inveighs against the schoolmen who slavishly follow ARISTOTLE (22) and then states in no uncertain terms his own *confessio fidei* concerning the work of the great Stagirite as follows : " And I here declare once for all, that where in the following Tract, or any other of my writings, I do *indefinitely* depretiate *Aristotle's* Doctrine, I would be understood to speak of *his Physicks*, or rather of the Speculative part of them, (for his Historical Writings concerning Animals I much esteem) nor do I say, that even these may not have their use among Scholars, and even in Universities, if they be retain'd and studied with due cautions and Limitations; (of which I have elsewhere spoken.)" (23)

His reservations concerning the Cartesians are similarly telling. " I have forborn to imploy Arguments," he says, " that are either grounded on, *or* suppose Indivisible Corpuscles call'd *Atoms*, or any *innate motion* belonging to them; *or* that the Essence of Bodies consists in Extension, *or* that a Vacuum is impossible; *or* that there are such *Globuli coelestes*, *or* such a *Materia subtilis*, as the Cartesians imploy to explicate most of the *Phaenomena* of Nature." (24) BOYLE's subsequent treatment of the " cor-

(22) BOYLE, R. *The Origine of Formes and Qualities*, Oxford, 1667, f. Ab5*b* : " I also forbear to answer Arguments, that however vehemently and subtly urg'd by many of the modern Schoolmen of the Roman Catholick Communion, are either confessedly, or at least really built upon some Theologicall Tenents of theirs, which being oppos'd by the Divines of other Churches, and not left unquestion'd by some Acute ones of their own, would not be proper to be solemnly taken notice of by Me, whose businesse in this Tract is to discourse of Natural things as a Naturalist, without invading the Province of Divines, by intermedling with Supernatural Mysteries, such as those, upon which divers of the Physico-Theologicall Tenents of the Schoolmen, especially about real Qualities, and the Separablenesse of Accidents from Subjects of Inhesion, are *manifestly*, if not also *avowedly* grounded. "

(23) *Ibid.*, f. Ab7*a*.

(24) *Ibid.*, f. Ab5*a*.

puscular " philosophy is conservative and at every point he is careful to distinguish between fact and theory. He considered the corpuscular theory of the world highly probable though unproved. We cannot here go into the full details of his argument and we must omit discussion of his doctrine of ' qualities,' the forerunner of the Newtonian conception of light, since this has been recently dealt with by IRVINE MASSON. (25)

In an oddly named tract, *An Essay of the Great Effect of Even Languid and Unheeded Motion* (1685), one finds BOYLE's theory of matter set forth in an even more complete form. His earlier works were richer in the record of experiment but his interpretations were then less mature. In his tract, " He first draws attention to the ' great effects ' which can be propagated by the air (*e.g.*, breaking of distant windows by cannon), and reiterates that any moving body whether liquid, gaseous or solid, evolves heat on encountering an impediment." Some passages suggest, " that he was thinking of a ' mechanical equivalent of heat ' and that he regarded heat itself as due to small particles of matter in ' local motion.' He also asks himself, parenthetically, whether lode-stones produce their influence through agitation of air particles, but he concluded in the negative on finding that iron filings are still affected when in a vacuum." (26) There are many passages in which he discusses the vibration of the ultimate particles of substances. On page 115, for example, he remarks, " That diamonds themselves will by rubbing upon woolen clothes be made electrical, seems to argue, that their Parts are set amoving."

BOYLE's virtual statement of the modern kinetic theory of gases occurs in a book published a few months after his death, entitled *The General History of the Air*. The book begins with a definition of the air which runs as follows : " By the *Air* I commonly understand that thin, fluid, diaphanous, compressible and dilatable Body in which we breath, and wherein we move, which envelops the Earth on all sides to a great height above the highest Mountains; but yet is so different from the *Aether* [or *Vacuum*] in the intermundane or interplanetary Spaces, that it refracts the Rays of

(25) MASSON, IRVINE. *Three Centuries of Chemistry. Phases in the Growth of a Science*, London, 1925.

(26) FULTON, J. F. " A Bibliography of the Honourable Robert Boyle," Proc. Oxf. Bibliog. Soc., 1932, *iii*, 1-160. (p. 101.)

the Moon and other remoter Luminaries." In another place he remarks, " It seems then not improbable to me, that our *Atmospherical* Air may consist of *three* differing Kinds of Corpuscles." Then on pages 6 and 7 occurs the following remarkable passage : " Only I shall here intimate, that though the Elastical Air seem to continue such, rather upon the score of its Structure, than any external Agitation; yet Heat, that is a kind of Motion, may make the agitated Particles strive to recede further and further from the Centers of their Motions, and to beat off those, that would hinder the freedom of their Gyrations, and so very much add to the endeavour of such Air to expand it self. And I will allow you to suspect, that there may be sometimes mingled with the Particles that are springy, upon the newly mentioned Account, some others, that owe their Elasticity, not so much to their Structure, as their Motion, which, variously brandishing them and whirling them about, may make them beat off the neighbouring Particles, and thereby promote an expansive Endeavour in the Air, whereof they are Parts." Making allowances for 17th-century diction, really no more complete or adequate statement of the kinetic theory of gases could have been offered.

It would be of some interest to know whether BOYLE studied the effect of temperature on the volume of gases. He was of course familiar with the expansion effect of heat, but the only detailed discussion which I have been able to find occurs in a brief and little-known tract called *A Discovery of the Admirable Rarefaction of the Air* published in 1671, and recording experiments carried out in 1662. Though he made no attempt to determine the coefficient of expansion of a gas for a degree of temperature, he remarks : " Furthermore, It may seem worth while, to observe, how much the utmost degree of Rarefaction by Heat, that Experiment has shewed us of the Air, falls short of the Degree of Expansion, to which it has been advanced in our Pneumatical Engine, the proportion betwixt these two Expansions being that of 1 to 70, or therabout." (27)

He also considers the volume of a bubble when the pressure is reduced : " To some perhaps it will seem more fit to consider,

(27) BOYLE, R. *Tracts. Of a Discovery of the Admirable Rarefaction of the Air*, etc., London, 1671, p. 25.

than easie to resolve, how, since the Corpuscles of the Air are acknowledg'd to be heavy, and those that remain, must be so wonderful thinly disperst, in the Cavity of the Receiver they come to be supported, and kept as it were swimming therein, and do not appear to subside by their own weight, the *Materia subtilis* (though the presence of that should be admitted) not appearing to have gravity, wherewith to sustain them; and the *Vacuum* (if that be suppos'd wherever the Aerial Particles are not) being too near a-kinne to nothing, to be able to oppose their descent: but though something may be suggested about the solution of this doubt, my haste obliges me to leave it such." (28)

VI

It now remains to give the evidence for the assertion that BOYLE influenced men of all walks of life in the 17th century and that his works were widely read. One cannot urge that the number of books published by a writer bears evidence of his popularity. However, in the case of BOYLE it is clear that his works were much sought after by printers for they often brought them out almost simultaneously in English and in Latin, and the frequent reprintings (29) would not have been undertaken had the books not sold widely. The large number of Continental reprints also speaks for their wide distribution. (30) The *Seraphick Love*, for example, had ten editions in English, two in Latin, one in French, and one in German. There are more than 200 entries in the bibliography of his separately published books, which would mean an average of nearly five editions of each separate publication. In addition to this his complete works in English were twice reprinted during the 18th century.

(28) *Ibid.*, p. 26.

(29) In his prefaces BOYLE often mentions that his books had sold well. Thus in the 'Proemial Discourse' to *Formes and Qualities* he says: "Having four or five years ago publish'd a little Physico-Chymical Tract about the differing parts and redintegration of Nitre, I found as well by other signs as by the early sollicitations of the Stationer for a new Edition, that I had no cause to complain of the reception that had been given it." (f. Ab1*a*.)

(30) With one or two exceptions all BOYLE's writings appeared in Latin on the Continent within a few years, and sometimes within a few months, of their publication in England.

Evidence of another sort is to be derived from the great number of books dedicated to BOYLE in the course of his life. I was able to list ten in my bibliography and two others have recently come to light : one a book by DANIEL GOOKIN, (31) an American

(31) GOOKIN, DANIEL. " Historical Collections of the Indians in New England," first printed from the original manuscript dated December 7, 1674, in *Collections Mass. Histor. Soc.*, 1792, i, 141-227 (Vol. I reprinted in Boston, 1806). The work is prefaced by " The Epistle Dedicatory " to Prince CHARLES followed by,

"An EPISTLE Gratulatory and Supplicatory

"*To the Right Honourable the Corporation for propagating the gospel in America, residing in London; and particularly for the Hon. Robert Boyle, Esquire, Governour thereof.*

"Right Honourable,

"These Collections do, in a special manner, implore your favourable aspect and protection; for God hath been pleased to honour and employ you, as eminent instruments to encourage and promote this great affair of his kingdom in this western world, for propagating the gospel of Christ among the poor and desolate Indians.

"The unworthy penman hereof desireth in all humility, to offer three words to your Honours.

"First, with all cordial acknowledgment, I thank your Honours for all that great condescension and labour of love, that from time to time you have shewed in your zealous and faithful promoting of this work, committed unto your care and trust by his Majesty.

"Secondly, to supplicate your unwearied countenance therin, and putting forth, not only your prayers, but, vigorous endeavours to further it; for truly the work is great, and that in special as it relates to the glory and honour of the great God, and his only Son, our Saviour Jesus Christ, in the salvation of these poor gentiles.

"Thirdly, that you will please to peruse, and seriously to consider, and, if it may suit with your wisdoms, put in practice, these proposals, that I have presumed to make in the 12th Chap. of this tractate, as a means, under God, to civilize the barbarous Indians, and propagate religion among them; especially in setting up some free schools to teach them to speak, read, write, and understand, the English tongue.

"So praying unto the God of all grace, to multiply upon every one of you, his richest and best blessings, I take leave, and remain,

"Right Honourable,
"your humble servant,
"DANIEL GOOKIN, Sen.

"Cambridge, in N.E. Dec. 7th, 1674."

GOOKIN also dedicated another work to BOYLE entitled " An Historical Account of the doings and sufferings of the Christians Indians in New England, in the year 1675, 1676, 1677," which was first printed in *Trans. and Collect. Amer. Antiq. Soc.*, 1836, ii, 423-534. " The Epistle Dedicatory " is dated Cambridge in N.E., December 18th, 1677. As far as I am aware these are the only contemporary dedications to BOYLE from the American colonies. I am greatly indebted to Dr. HERBERT THOMS, of the Yale School of Medicine, for directing my attention to them.

writer on Indian customs, and the other by JOHN EVELYN. (32) The esteem in which he was held is perhaps to some extent indicated too by the fact that his funeral sermon was reprinted four times and that at the time of his death five different necrological sheets and elegies appeared from the London presses within a period of a few weeks. (33)

Much more eloquent, however, is the evidence to be derived from the works of his contemporaries. The diaries of EVELYN and PEPYS abound in references to BOYLE, several of which may be quoted. EVELYN was evidently one of BOYLE's closest friends and certainly one of his warmest admirers. A considerable part of their correspondence has been preserved. On September 29, 1659, EVELYN wrote, after reading the manuscript of *Seraphick Love*, " I extremely loved you before; but my heart is infinitely knit to you now." (34) On September 13, 1661, he wrote him again : " I have not bought two of your last books, & yet possibly I could render you some account of them. My thirst and impatience is too great to shew the least indifferency, when any thing of your's is to be had; this does not absolve you from making him a present who, it may be, takes no greater felicity in the world than to see his small library enriched with your illustrious works, & they to come to me *ex dono authoris*." (35) Under November 30, 1680 (St. Andrew's Day) is a more significant passage written in Evelyn's maturer years : " The anniversary election at the Royall Society, brought me to London, where was chosen President that excellent person and greate philosopher Mr. Robert Boyle, who indeede ought to have ben the very first; but neither his infirmitie nor his modestie could now any longer excuse him." (36)

In EVELYN's diary there are also many references to BOYLE's individual experiments, the following of which may be cited : " May 7th. [1662] I waited on Prince Rupert to our Assembly,

(32) *Diary of John Evelyn*, edited by H. B. WHEATLEY, 4 vols., London, 1906, *ii*, 147 : " 10th. [June, 1662] I returned to London, and presented my ' History of Chalcographie ' (dedicated to Mr. BOYLE) to our Society."

(33) Full details concerning these sheets are to be obtained in the Bibliography of BOYLE, see 12.

(34) EVELYN, *op. cit.*, *iii*, 273.

(35) *Ibid.*, *iii*, 281.

(36) *Ibid.*, *ii*, 374. BOYLE, however, declined the chair.

where were tried severall experiments in Mr. Boyle's *vacuum*. A man thrusting in his arme upon exhaustion of y^e^ aire had his flesh immediately swelled so as the bloud was neere bursting the veines : he drawing it oute we found it all speckled." (37) " 24th. [October, 1664]... I went to visit Mr. Boyle (now here), whom I found with Dr. Wallis and Dr. Ch^r^ Wren in the tower of the scholes, with an inverted tube or telescope, observing the discus of y^e^ sunn for y^e^ passing of Mercury that day before it." (38)

The references to BOYLE in PEPYS' Diary (39) are amusing and reflect the attitude of a layman confronted for the first time by a scientific treatise. Thus on April 28, 1667 PEPYS noted : " and so to supper and to read, and so to bed, mightily pleased with my reading of Boyle's book of colours to-day, only troubled that some part of it, indeed the greatest part, I am not able to understand for want of study." (40) A little later (May 26), referring to the same work, " I took another book, Mr. Boyle's of Colours, and there read, where I laughed, finding many fine things worthy observation." (41) A third reference to the book occurs on June 2 : " Being weary and almost blind with writing and reading so much to-day, I took boat at the Old Swan, and there up the river all alone as high as Putney almost, and then back again, all the way reading, and finishing Mr. Boyle's book of Colours, which is so chymical, that I can understand but little of it, but understand enough to see that he is a most excellent man." (42) On June 10 he had started another of Boyle's works : " So I homeward, as long as it was light reading Mr. Boyle's book of Hydrostatics, which is a most excellent book as ever I read, and I will take much pains to understand him through if I can, the doctrine being very useful." (43) Similarly, on July 24 : " all the way with extraordinary content reading of Boyle's Hydrostatickes, which the more I read and understand,

(37) *Ibid.*, *ii*, 144.
(38) *Ibid.*, *ii*, 170.
(39) PEPYS, S. *The Diary*, edited by H. B. WHEATLEY, London, 1920, 9 vols.
(40) *Ibid.*, *vi*, 292,
(41) *Ibid.*, *vi*, 338.
(42) *Ibid.*, *vi*, 347.
(43) *Ibid.*, *vi*, 358.

the more I admire, as a most excellent piece of philosophy." (44) A further amusing reference to ' Formes and Qualities ' appears on April 1, 1668 : " Thence called at my bookseller's, and took Mr Boyle's Book of Formes, newly reprinted, and sent my brother my old one." (45)

There are many other references to BOYLE in the writings of his literary contemporaries, particularly among theologians and those theologically inclined. A large part of his extensive correspondence with scientists at home and abroad has also survived, but this has already been described in the excellent biographies of BIRCH (46) and FLORA MASSON. (47)

The recently published *Conway Letters*, (48) which consists largely of the correspondence between ANNE CONWAY and HENRY MORE, contain many allusions to BOYLE deserving of special mention. It should be recalled that BOYLE and MORE came into conflict over BOYLE's hydrostatical experiments. (49) MORE's initial scepticism, which incidentally was quite unfounded, is seen in the following passages : " I will bring Mr Boiles Hydrostaticks with me, which I made bold to carry away upon a presumption I should sooner have returned. It is a very pleasant discourse, though I be not altogether satisfyde that his paradoxicall Inferences from the experiments are true. There will be a Spiritt of Nature for all this, and I think for anything that ever will be alledg'd to the contrary, or excogitated to evade the unrelish of that principle." (50) And again on April 28, 1666 : " Dr. Cudworths little son has received reall good from Mr Greatrakes, and Mr Boyle told me that he had been a spectatour of at least 60 performances of his. I believe that gentleman is likely to doe him more creditt then any body. Mr Boyle resented Dr Stubs his letter very ill, I perceiv'd by what he sayd to me.

(44) *Ibid.*, *vii*, 35.

(45) *Ibid.*, *vii*, 386.

(46) BIRCH, T. *The Works of the Honourable Robert Boyle in Five Volumes. To which is prefixed The Life of the Author*, 1st ed., London, 1744.

(47) MASSON, FLORA. *Robert Boyle : A biography*, London, 1914.

(48) *Conway Letters*, edited by MARJORIE HOPE NICOLSON, New Haven, Yale University Press, 1930.

(49) BOYLE, R. *Hydrostatical Paradoxes*, Oxford, 1666.

(50) *Conway Letters*, p. 269. HENRY MORE to LADY CONWAY, March 17, 1666.

I know not how the Doctor will come off." (51) After BOYLE had replied, (52) MORE assumes a rather disturbed tone in reference to the controversy : " Mr Boyle does not take my dissenting so from him in publick so candidly as I hoped, which I am very sorry for. For he is a person that I have a singular honour and esteeme for as I do cordially and simply declare in the book in which I meddle with his notions, and thought Philosophy had been free. If any body had confuted any thing of mine with such circumstances as I have done, I cannot perceive that that would have given me the least disgust in the world. If he were mistaken I would with the same kindnesse demonstrate his errour to the world, and lett them judge." (53)

There are also a series of amusing passages concerning *Ens veneris*, (54) one of BOYLE's medicines which had been recommended to LADY CONWAY by HENSHAW : " Dr Hernshaw perswades me to make tryall of a medison of Mr Boyles called, Ens Veneris. I hade some of the powder from him, but because he bought it, I am fearfull it may not be so well prepared as what you may be able to procure from his owne hand, which I suppose you may easily doe by my Lord of Orrerys meanes, and mineralls are not safely made use of if any error be committed in the making of them. Dr Hearnshaw thinks it good for the scurvy and for a weak stomach, and says Mr Boyle commends it for an invetterate headache, but if you have an oppertunity of discoursing with himself he is best able to give an account of the effects of his owne medison, and it being easie to take I am willing to make tryall of it. I believe I am hugely afflicted with the scurvy, and am so very much indisposed all over, that I should be very glad to have some discourse with the physitians, if I were at London." (55)

(51) *Ibid.*, p. 273. HENRY MORE to LADY CONWAY, April 28, 1666.

(52) BOYLE, R. *New Experiments, touching the Relation betwixt Flame and Air. And about Explosions. An Hydrostatical Discourse oc-casion'd by some Objections of Dr. Henry More against some Explications of New Experiments made by the Author of these Tracts*, Oxford, 1672.

(53) *Conway Letters*, p. 358. HENRY MORE to LADY CONWAY, May 11, 1672.

(54) BOYLE, R. *Of the Reconcileableness of Specifick Medicines to the Corpuscular Philosophy*, London, 1685. (P. 201.)

(55) *Conway Letters*, p. 225. LADY CONWAY to her husband, September 4, 1664. Also pp. 226, 228, 229, 230.

VII

SUMMARY AND CONCLUSION

Toward the end of the 19th century, Science had been accepted by the chief universities of the world and it had begun to shape the lives and thought of all civilized races of the Occident. Its recognition, however, had been slow, and its influence upon the course of human history has never been adequately traced. ROBERT BOYLE (1627-1692) was one of the first in Science whose work was widely read by the lay public, and through this circumstance he exerted a far more important influence than is commonly recognized. He wrote in a language that his contemporaries could understand, and he undoubtedly did more than anyone of his time to make Science a part of the intellectual equipment of educated men. BOYLE had never been a student at a university and throughout his active life he declined to occupy a chair. He touched nearly all branches of knowledge, however, and there is no division of modern Science, except possibly astronomy, which cannot trace phases of its origin in his writings. In addition to his well known contribution to the gas laws he was the first modern protagonist of the atomic structure of matter and he gave a clear statement of the kinetic theory of gases. He studied respiration, the chemical nature of blood and urine, magnets and electricity; but of even greater importance was the enunciation of a theory of combustion and respiration which recognized the dependence of the process on a substance extracted from the air. As Professor T. S. PATTERSON has recently shown, MAYOW's theory of combustion was drawn largely from BOYLE without acknowledgment. BOYLE's contribution to Science was thus great, but it is urged that his success in placing Science on an equal footing with the other intellectual disciplines represents an even more far-reaching achievement.

New Haven, Connecticut. J. F. FULTON.

"Ballad of Gresham Colledge"

Among the manuscripts in the British Museum are three slightly differing versions (1) of a ballad on the Royal Society composed probably in 1663 when the Society had been chartered less than a year. Although PEPYS (2) expressed a fear of the ballad-writers when the Society was to entertain as its guest the fantastically brilliant DUCHESS OF NEWCASTLE, yet contemporary ballads on these subjects are almost unknown today. The publication of this one in full seems therefore justifiable, for it gives early evidence of the Society's activities and of the enthusiastic though amused interest taken in them by a well-informed observer. In addition, the ballad seems to be the youthful work of JOSEPH GLANVILL, (3) a well known writer of the seventeenth

---

(1) Add. MS. 34, 217, fos. 30*v*-314; Sloane MS. 1,326, fos. 116-120*v* (in the letter-book of Dr. HENRY POWER and hereafter referred to as "H.P."); Sloane MS. 363, fos. 38-41 (hereafter referred to as "Sl."). Though the title of this article is drawn from the conclusion of the last, the first is the copy used for publication. In its margin are notes giving clues to the identity of the individuals described. Of the twenty-eight verses only seven have hitherto been published: verses 2, 5, 12, 26, by "W. GLANVILL" in C. R. WELD's *History of the Royal Society*, London, 1848, vol. I, pp. 79-80, note 10; verses 2, 4, 8, 11, by "JOSEPH GLANVILL" in I. MASSON's *Three Centuries of Chemistry*, London, 1925, pp. 48-49. My thanks are due to Mr. WALLACE NOTESTEIN for first calling my attention to this ballad, and to Dr. CHARLES SINGER for his kindly criticism. The material for this article was collected while the author was a Fellow on the John Simon Guggenheim Memorial Foundation.

(2) *Diary*, edited by H. B. WHEATLEY, London, 1904, vol. VI, p. 343.

(3) JOSEPH GLANVILL, (1636-1680), Exeter College, Oxford, B.A., 1655; Lincoln College, M.A., 1658. Appointed to the rectory of Wimbish, Essex, in 1661, and to Frome Selwood, Somersetshire, in November 1662; inducted rector of the Abbey Church, Bath, June 23, 1666; given other appointments later. A friend of the founders of the Royal Society and a prolific writer, he was a vigorous defender of experimental philosophy in a controversy with HENRY STUBBE. (*Biographia Britannica*. A. WOOD, *Athenae Oxonienses*, Oxford, 1691-2, vol. II, pp. 495-7.)

century, a possibility that has been recognized only recently. (4)

Although the contemporary evidence of the copy in Dr. HENRY POWER's (5) letterbook ascribes (6) the ballad's authorship to a Mr. W. GLANVILL, that this ascription was a copyist's error is easily possible since Dr. POWER's relations with the Royal Society in London were chiefly by correspondence from his home near Halifax, and since this statement is clearly not in his own handwriting but in that of this copyist. Furthermore, no " W." GLANVILL is to be found either among the virtuosi themselves or among the prominent men of the day. (7) On the other hand, this ballad with its detailed and accurate knowledge of the affairs of the Royal Society implies on the part of its author just such knowledge as was readily obtainable by JOSEPH GLANVILL, " an eminent divine, a general scholar, and a very polite writer " then in his twenty-seventh year. For JOSEPH GLANVILL was not only well acquainted with many of the virtuosi through his college life at Oxford and his later residence in and near London, but he was also by 1662 an intimate friend of FRANCIS WILLUGHBY, already one of the fellows. (8) Furthermore, his sympathy with its work was recognized by the Society in 1664 when he also was elected into the membership.

---

(4) MASSON, *op. cit.*, pp. 48-9.

(5) HENRY POWER (1623-1668), Christ's College, Cambridge, B.A., 1644; M.A., 1648; M.D., 1655. In correspondence with the Royal Society from 1661 on (see " H.P." and *Journal* of the Royal Society from October 23, 1661 on); elected F.R.S. July 1, 1663. [References to the *Journal* of the Royal Society are by date only, in order to facilitate comparison with the originals and the manuscript copies (both in the library of the Royal Society), and with the printed version in T. BIRCH's *History of the Royal Society*, London 1746.]

(6) H.P. fo. 120 : " By Mr. W. G."; " The end of Mr. Glanvill's verses."

(7) No *William* GLANVILL is mentioned in the *Biog. Brit.* nor in the *Dict. Nat. Biog.* and WOOD refers only to a Doctor of Physic by this name. There is evidence showing that three WILLIAM GLANVILLS had some connection with Oxford about this time. One was at Exeter College in 1634 at the age of 16 and later became a member of the Middle Temple. A second was made doctor of physic in 1643 and lived in Oxford after that until his death in 1680. A third matriculated at University College in 1666 at the age of 15. (J. FOSTER, *Alumni Oxonienses*, 1500-1714, Early Series, Oxford, 1892, ii, 570; A. WOOD, *op. cit*,. ii, 722.) This last was too young to be the author of a ballad composed in 1663. The second would have been referred to as " Dr." in this period rather than as " Mr.", and both he and the first mentioned would seem to have been too old in 1663 to have written with the youthful exuberance characteristic of these verses

(8) [J. GLANVILL], *Lux Orientalis*, London, 1662, dedication to WILLUGHBY.

This theory of JOSEPH GLANVILL's authorship is supported by internal evidence. The detailed information about the Royal Society contained in the ballad was easily available to GLANVILL through his friendship and association with the virtuosi. The scorn for the Aristotelian pedantry of the universities, and the enthusiastic praise of the new science are both in harmony with his previously published *Vanity of Dogmatizing* (1661). (9) In addition the exuberantly enthusiastic tone of the ballad implies a youthful author such as GLANVILL was at this time (10) and the prosy doggerel indicates an inexpert ballad-writer. Unfortunately comparison with other verses by JOSEPH GLANVILL is impossible since no others are known, unless, perhaps he wrote the anonymous ballad (11) on the death of the DUCHESS OF NEWCASTLE in 1674 that is akin to these in verse-form and prosiness.

The circumstances of JOSEPH GLANVILL's life at this period also harmonize with this theory. He had been at Oxford when BOYLE and WILKINS were leaders of the science-lovers there in the Cromwellian period; he had already published, in the same enthusiastic vein as the ballad, his *Vanity of Dogmatizing* (1661) in protest against the Aristotelianism of the schools and in praise of the new philosophy; and he could have kept in close touch with any new scientific movement in London like the formation of the society " for the promotion of experimental learning " not only through his acquaintance among the virtuosi and especially

(9) J. GLANVILL, *Vanity of Dogmatizing*, London, 1661, p. 142 : " If we owe it to him [ARISTOTLE] that we know so much; 't is long of his Pedantick adorers that we know as little more;" p. 152 : " A Schoolman is the Ghost of the Stagirite, in a Body of condensed Air."

(10) *Diary and Correspondence of Dr. John Worthington*, CROSSLEY, Chetham Society, London, 1857, i, 300-1 : Worthington to Hartlib, April 19, 1661, " He [GLANVILL] is a young man, and abating some juvenile heat, there are good matters in his book." See also BEAL's letter to BOYLE, Oct. 31, 1666, *Boyle's Works*, London, 1744, v, 488 : " He [Mr. GLANVILL] hath a flowery pen and may do well if we can ballast him from Origenian Platonism and extravagant adventures... but his genius is apt for sublime adventures."

(11) *Letters and Poems in Honour of the Incomparable Princess, Margaret, Dutchess of Newcastle*, London, 1676, pp. 172-4, " Upon the death of the Illustrious and Incomparable Lady, Margaret, Dutchess of New-Castle." See LESLIE STEPHEN, " Joseph Glanvill " in *Dict. Nat. Biog.* By the mis-reading of an ' r ' for an ' l ' FERRIS GREENSLET has attributed to GLANVILL four lines of a stanza quoted from GRANVILL by Dr. JOHNSON in his *Dictionary* under " Festival," *Joseph Glanvill*, New York, 1900, p. 80, n. 1.

through his friend WILLUGHBY but also through his frequent presence in London in 1661 (12) and probably in 1662 also. His election to membership in the Royal Society in 1664 shows that his moving from his rectory in Wimbish, Essex, in November, 1662, to his new living in Frome Selwood, Somersetshire, had not severed his connection with these friends. It seems possible to assume, therefore, that after GLANVILL had moved to Somerset, he sent this ballad early in 1663 to the virtuosi in London, and that they in their turn, passing it about among themselves, had a copy sent to another correspondent, Dr. POWER at " Newhall near Hallifax." He, supposedly knowing " Mr. GLANVILL " by reputation only, failed to note his copyist's error in attributing its authorship to Mr. W. GLANVILL.

The dating of the ballad by the copyist in " 1662 " (13) is with two possible exceptions confirmed by reference in the ballad itself to specific events or publications, provided that the old style calendar ending the year on the following March 24th is understood. One exception is that Sir PAUL NEILE (14) did not give his fifty-foot " optic tube " to the Society until September, 1664, (see verse 7); but it is conceivable that he may have allowed the members to use it for some time previous to this date. The other exception is that in his earlier experiments with the airpump, BOYLE reports (15) using various small animals including a puppy, and does not mention the cat (see verse 8); however a cat in the receiver of the airpump is pictured in the first plate of the

(12) R. BAXTER, *Second True Defence of the Meer Nonconformists*, London, 1681, pp. 179-182, (a letter from GLANVILL to BAXTER written September 3, 1661).

(13) H.P., fo. 117 : " 1662." As the ballad is preceded in the letterbook by a letter dated December 12, 1662, and is followed by one dated November 28, 1663, and as with the two exceptions noted, all the references are to happenings before April, 1663, and to one or two after December, 1662, it seems probable that the ballad was written early in 1663, or before the end of 1662, old style.

(14) Sir PAUL NEILE, son of RICHARD, Archbishop of York, (1562-1640) and father of WILLIAM NEILE (1637-1670) was courtier, astronomer and instrument-maker. He was named on the council of the Royal Society by both charters, the first describing him as " Knight, one of the Gentlemen of our Privy Chamber," the second, as an " Usher of our Privy Chamber ". On September 21, 1664, he offered the Society his fifty-foot telescope. On October 1, 1661, the Society was using the thirty-five foot one he had given it.

(15) R. BOYLE, *New Experiments Physico-Mechanicall*, Oxford, 1660, pp. 326-334, 369; 2nd ed., 1662, pp. 169-173, 191.

Continuation (1669) of those experiments, although no experiment with animals is described in the book itself. Probably, however, kittens as well as puppies were used in 1661 and 1662 when the Society was constantly experimenting with the " pneumatic engine."

With these exceptions, all the references belong to the years immediately preceding 1663 and none to a later time. It is as the probable work of JOSEPH GLANVILL in 1663, therefore, that the ballad is now presented.

Goucher College. DOROTHY STIMSON.
Baltimore, Md.

" In Praise of that choice Company of Witts and Philosophers who meet on Wednesdays weekly att Gresham Colledg. (1)

1.

If to be rich and to be learn'd
Be every Nation's cheifest glory,
How much are English men concern'd,
Gresham (2) to celebrate thy (*a*) story
Who built th'Exchange t'enrich the Citty
And a Colledge founded for the witty.

2.

Our Merchants on th'Exchange doe plott
T'increase the Kingdom's wealth by trade.
Att Gresham Colledge a learned Knott
Unparallel'd designes have laid
To make themselves a Corporation
And knowe all things by Demonstration.

3.

Seaven was the number of the Sages;
The eight wiseman wee call a Foole.
Our Fame must then exceed all Ages
Who have (*b*) Seaventie wise men in one Schoole.
Wee adore (*c*) the, Gresham, for thy Colledge
From whence must issue soe much Knowledg.

(*a*) H.P. fo. 116 and Sl. fo. 38 : " in."
(*b*) H.P. fo. 116 : " Who've."
(*c*) H.P. fo. 116 : " W' adore."

(1) Brit. Mus. Add. MS. 34,217, fos. 30*v*-31*r*. [Punctuation has been added, and abbreviations expanded; but the spelling has not been changed.]

(2) About 1575 Sir THOMAS GRESHAM, " King's merchant " and founder of the Royal Exchange, established a foundation for a college in his own house to provide London with free public lectures by seven professors. In 1657 after LAWRENCE ROOKE and CHRISTOPHER WREN were made Gresham professors of geometry and astronomy, respectively, science-loverr developed the habit of meeting for discussion in their rooms after the weekly lectures. The College therefore became the meeting-place for the newly organized society in 1660.

4.

This learned Septuagint consists
Of men of Honor and of parts.
There's L[or]ds, Kn[igh]ts, Physicians, Priests,
All skill'd in Sciences and Arts,
Solomons in nature and can read there (*a*)
Even from the Hysop to the Cedar. (3)

5.

Thy Colledg, Gresham, shall hereafter
Be the whole world's Universitie,
Oxford and Cambridge are our laughter;
Their learning is but Pedantry.
These new Collegiates doe assure us
Aristotle's an Asse to Epicurus. (4)

6.

By demonstrative Philosophy
They playnly prove all things are bodyes,
And those that talke of Qualitie
They count them all to be meer Noddyes.
Nature in all her works they trace
And make her as playne as nose in face. (*b*)

(*a*) H.P. fo. 116*v*., " hei ;" Sl. 38*v* : " here."
(*b*) Sl. fo. 38*v* : " as plane as the nose in your face."

(3) I Kings 4:33 : " and [Solomon] spake of trees from the cedar that is in Lebanon even unto the hyssop that springeth out of the wall."

(4) GLANVILL, *Vanity*, p. 146 : " Thus the Aristotalian Philosophy hath prevailed; while the more excellent hypotheses of Democritus and Epicurus hath long lain buryed under neglect and oblivion;" p. 152:" To me, a *cursus Philosophicus* is but an Impertinency in Folio; and the studying of them a laborious idleness... Its principles are steril, unsatisfying verbosities;" see also, pp. 166, 171-7.

7.

"T was broach't att first but to make myrth
There was another world i' th'Moone : (5)
The Colledg proves that Globe and Earth
And Made 't as playne as day att Noone, (6)
Nay, in a glasse of Fiftie Foot (7)
They shew us (*a*) Rivers and Trees to boot. (8)

8.

To the (*b*) Danish Agent (9) late (*c*) was showne
That where noe Ayre is, there's noe breath.
A glasse this secret did make knowne
Where [in] (10) a Catt was put to death. (11)
Out of the glasse the Ayre being screwed,
Pusse dyed and ne're so much as mewed.

(*a*) H.P. fo. 117 and Sl. 38*v* : " you."
(*b*) H.P. fo. 117 : " th'."
(*c*) Sl. 38*v* : " lately."

(5) In margin : " Mr. Wilkins." " *The Man in the Moone, or Discourse of a Voyage Thither by D. Gonsales*," London, 1638, written by FRANCIS GODWIN (1562-1633), probably about 1600, was published posthumously the same year that JOHN WILKINS first published the *Discovery of a World in the Moone, or a Discourse Tending to Prove that 't is probable there may be another habitable World in that Planet*, London, 1638. WILKINS re-issued this discourse in 1640 with an additional proposition (XIV) " On the Possibility of a Passage thereto " and a reference (p. 133) to Bishop GODWIN's " very pleasant and well contrived Fancy " which he had not seen before. The earlier account is in story form and though Copernican in its astronomy, may not have been intended seriously; WILKINS' *Discovery* is a bold logical presentation of the latest astronomical evidence. His second discourse was " *Concerning a New Planet Tending to prove, That ('t is probable) our Earth is one of the Planets*," London, 1640. See also, GLANVILL, *Vanity*, p. 182 on the possibility of a voyage to the moon.

(6) *Journal*, May 8, 1661 : The Society proposed to write to WREN and charge him in the king's name to make a globe of the moon.

(7) In margin : " Sir P. Neale."

(8) See R. Hooke, *Micrographia*, London, 1665, pp. 242-3.

(9) *Journal*, February 13, 1660-1 : The Danish ambassador visited the Society and " was entertained with experiments on Mr. BOYLE's air-pump." January 21, 1662-3 : Mr. HOOKE's inquiries for Iceland were referred " to the Danish lord who was lately an ambassador in England and gave the Society a visit.'

(10) Supplied from H.P. fo. 117 and Sl. fo. 38*v*.

(11) In margin : " Mr. Boyle."

9.

The selfe same glasse did likewise clear
Another secret more profound :
That nought but Ayre unto the Eare.
Can be the Medium of Sound,
For in the (*a*) glasse emptied of Ayre
A striking watch you cannot heare. (12)

10.

And that which makes their Fame ring louder,
With much adoe they shew'd the King
To make glasse Buttons turn to powder,
If off the[m] (*b*) their tayles you doe but wring.
How this was donne by soe small Force
Did cost the Colledg a Month's discourse. (13)

11

These men take nothing uppon trust (14)
Therefor in Counsell sate many howres
About fileing Iron into Dust
T'experiment the Loadstone's powers;
If in a Circle of a Board they strew it,
By what lines to see the Loadstone drew it. (15)

(*a*) H.P. fo. 117 : " this."
(*b*) H.P. fo. 117*v* and Sl. 39 : omit " them."

(12) *Journal*, February 12, 1661-2 : " Dr. WREN proposed to try a watch in Mr. BOYLE's engine;" BOYLE, *New Experiments*, Oxford, 1660, pp. 210-212; 2nd ed., 1662, pp. 105-108.

(13) *Journal*, March 4, 1660-1 : The Society began the study of " five little glass bubbles " sent them by the king through Sir PAUL NEILE. Others were made and many experiments carried on with them both for study and for exhibition to visitors. On August 14, 1661, Sir ROBERT MORAY made a report on them. Dr. CHRISTOPHER MERRET added this to his translation of ANTONIO NERI's *Art of Glass*, London, 1662, pp. 353-362.

(14) The Society's motto is " Nullius in Verba."

(15) See R. DESCARTES, *Principia Philosophiae*, Amsterdam, 1654, part iv, pp. 267-294 : on the magnet, with experiments illustrated by diagrams. (GLANVILL quotes from this part iv in *Lux Orientalis*, p. 192.) The *Journal* records much experimentation with loadstones by the Royal Society in 1662.

12.

The (*a*) noble learned Corporation
Not for itselfe is (*b*) thus combyn'd
But for the publique good oth'Nation
And generall benefitt of Mankynd.
These are not men of common mould :
They covet Fame but contemne gold.

13.

But yett they'd have the Colledge endow'd
With about a thousand (*c*) pounds a year. (16)
Such a Revenue being allow'd,
What things they'll doe shall then appeare.
Each single Member hath undertooke
To shew a Trick or write a Booke. (17)

14.

The Prime Virtuoso hath undertaken
Through all the (*d*) Experiments to run (18)
Of that learned Man, Sir Francis Bacon,
Shewing which can, which can't, be donne.
If he doe not, be sure that none
Will ever fynd the Philosopher's stone.

(*a*) H.P. fo. 117*v* and Sl. fo. 39 : " This."
(*b*) H.P. fo. 117*v* : " themselves are."
(*c*) H.P. fo. 118 and Sl. fo. 39*v* : " Ten thousand."
(*d*) H.P. fo. 118 : " th'."

(16) Probably a reference to plans culminating in the king's futile request to the DUKE OF ORMOND, governor general of Ireland, September 1662, asking him to secure contributions for the Royal Society from the " adventurers and officers " then in Ireland. (See copy of letter in Royal Society MS. : *Miscell. I*, " Papers of Council, Committees, etc." WELD, *op. cit.*, i, 130-134.)

(17) *Journal*, April 2, 1662 : " It was resolved that every member of the Society shall consider against the next meeting of some experiment which he will undertake himself."

(18) In margin : " Sir R.M." Sir ROBERT MORAY (d. 1673), a royalist and Scotch Presbyterian. As one of the founders of the Royal Society, he frequently served as an intermediary between the Society and the king. For more than a year before its incorporation in July, 1662, he was its presiding officer.

15.

A second hath describ'd att full (19)
The Philosophie of making Cloath,
Tells you what grasse doth make coarse wooll
And whatt it is that breeds the Moth.
Great learning is i'th' Art of Cloathing
Though vulgar people thinke it nothing.

16.

A wondrous Engine is contriveing
In forme, t'is said, much like a Bell,
Most usefull for the Art of Diveing.
If 't hitt, 't will prove a Miracle;
For, gentlemen, 't is no small matter
To make a man breath under water. (20)

17.

A newe designe how to make Leather
A third Collegiate is now scaning. (21)
The Question most disputed : wheather, (*a*)
Since without Barke there may be taning,
Some cheaper way may not be tryed
Of making Leather without Hyde.

(*a*) H.P. fo. 118*v* : " The Question disputed 's whither."

(19) In margin : " Sir Wm. P." Sir WILLIAM PETTY (1623-1687), political economist and man of many activities, was one of the Oxford group which formed a nucleus for the London society in 1660. *Journal*, January 23, 1660-1 : " Dr. Petty was desired to deliver in his thoughts concerning the trade of clothing at the next meeting." This he did not do, however, until November 27, 1661.

(20) From May 1 to July 24, 1661, the *Journal* records a number of references to a diving bell and to experiments made with it with some degree of success.

(21) In margin : " Mr. How." Mr. CHARLES HOWARD, son of the DUKE OF NORFOLK, was elected a Fellow December 31, 1662. According to an undated but very early memorandum he was desired " to bring in the History of Tanning, the old and new way." (R.S.MS. : *Miscell.* I; " Papers of Councils, Committees, etc.")

18.

Another person of great noate (22)
Hath writt a Learned tract of Strawe,
The tallest Beane stalke and smallest moate
From their first principles to drawe.
A fifth writes that in no tyne [sic] shorter
Then twen[t]y yeers can be made good Morter. (23)

19.

A sixth is perfecting a treatise
Of Draweing, Paynting, Lymning, graveing,
A most Ingenious peece, some say 'tis,
And wilbe richly worth men's haveing
For it declares the very Prime Age
Either (*a*) of Painter or of Image. (24)

20.

It proves that Aaron, the Jewes' high Priest,—
A controversie worth the cleering,—
Must fall within the sculpture's List;
When he mad Golden Calfe of Eare Ring,
He needs must use a toole of Mould,
For fire could never shape the gold.

(*a*) H.P. fo. 119 : " Whither."

(22) In margin : " Sir K. Digby." *A Discourse Concerning the Vegetation of Plants Spoken by Sir Kenelme Digby at Gresham College, on 23 January, 1660, at a meeting of the Society for promoting Philosophical Knowledge by Experiments*, London, 1661. It includes a description of the marvellous growth of an oak out of an " akehorne " and of a tall, green, tender plant out of a bean (pp. 8-9).

(23) This reference has not been located. Possibly it is connected with the instructions given the " amanuensis " (*Journal*, March 26, 1662), that " he make cement for Mr. Rooke according to Mons. Huygens' directions."

(24) J. EVELYN, *Sculptura, or the History and Art of Chalcography and Engraving in Copper, with an ample enumeration of the most renowned masters and their Works*, London, 1662.

21.

A Doctor counted very able
Designes that all Mankynd converse shall,
Spite o' th' confusion made (*a*) att Babell,
By Character call'd Universall. (25)
How long this Character will be learning,
That truly passeth my discerning.

22.

To guesse by one every one's (*b*) meritt,
A Booke call'd Fumifugiam read. (26)
Its Author hath a publique spirit
And doubtlesse too a subtile head
He must be more than John an Oake (27)
Who writes soe learnedly of smoake.

23.

He shewes that 't is (*c*) the seacoale smoake
That (*d*) allways London doth Inviron,
Which doth our Lungs and Spiritts choake,
Our hanging spoyle, and rust our Iron.
Lett none att Fumifuge be scoffing
Who heard att Church our Sundaye's Coughing. (28)

(*a*) H.P. fo. 119 and Sl. 40*v* : " was."
(*b*) H.P. fo. 119*v* and Sl. 40*v* : " man's."
(*c*) H.P. fo. 119*v* : " He shews it is."
(*d*) Sl. 40*v* : " Which'.'

(25) Dr. JOHN WILKINS (1614-1672) having continued the interest he expressed in his *Mercury, the Secret and Swift Messenger*, London, 1641, in devising a universal " character," or symbolic writing, to offset the curse of many languages resulting from Babel (chap. 13), was " put in mind " by the Royal Society (*Journal*, October 29, 1662) to " prosecute his design." *His Essay towards a Real Character and a Philosophical Language* was published by order of the Society in 1668.

(26) In margin : " Mr. Evel." J[OHN] E[VELYN], *Fumifugium, or the Inconveniencie of the Aer and Smoak of London dissipated*, London, 1661.

(27) *O.E.D.* : " A ninny or fool."

(28) " It is this which diffuses and spreads a Yellownesse upon our choycest Pictures and Hangings... For is there under Heaven such Coughing and Snuffing to be heard, as in the London Churches and Assemlies of People, where the Barking and Spitting is uncessant and most importunate ? " *Fumifugium*, pp. 7, 10.

24.

For melioration of the Ayre
Both for our Lungs and eke our noses,
To plant the Fields he doth take care
With Cedar, Juniper and Roses, (29)
Which, turn'd to trees, 't is understood,
Wee shall instead of coale burne wood. (*a*)

25.

O blessed witt that thus contrives
By (*b*) new found out but facile Arte
In pleasure to lengthen out our lives.
To teach us next to perfume — (30)
And without fuell or smoake make fire
Some other Member will aspire.

26.

The Colledge will the whole world measure,
Which most impossible conclude,
And Navigation make a pleasure
By fynding out the Longitude. (31)
Every Tarpaulin (32) shall then with ease
Sayle any ship to the (*c*) Antipodes

(*a*) H.P. fo. 119*v* and Sl. 40*v* : " Insteade of coales wee shall burn wood."
(*b*) Sl. fo. 40*v* : " With."
(*c*) H.P. fo. 120 and Sl. 41 : " th'."

(29) *Fumifugium*, pp. 24-26 : The low grounds to the east and southwest of London were to be planted with odoriferous shrubs and flowers as well as with marketable plants, " for health, profit, and beauty."

(30) This omission (mard?) occurs in all three copies.

(31) *Journal*, October 29 and November 12, 1662 : Dr. WILKINS mentioned Mr. THOMAS STREETE's proposition about the longitude. It was referred to LORD BROUNCKER and Sir ROBERT MORAY for consideration before having it presented to the king.

(32) *O.E.D.* : " A nickname for a mariner or sailor, especially a common sailor, now rare or archaic."

27.

Of all the Arts Mechanicall
Printed shalbe a perfe[ct] (*a*) Scheme, (33)
And every Science Liberall
Shall be likewise a Colledge Theame.
When the King hath made them (*b*) a Societie, (34)
They'll demonstrate all things but a Dietie. (35)

28.

These be the things with many more
Which miraculous appere to men
The Colledge intended : The like before
Were never donne, nor wilbe agen. (*a*)
And to conclude in Ballad Fashion.
God blesse the King and this new Corporation."

(*a*) Supplied from H.P. fo. 41 and Sl. fo. 120.
(*b*) Sl. fo. 41 : " 'em."
(*a*) H.P. 120*v* and Sl. 41 : " nor will againe."

(33) Part of the plans of the Society were for histories of all the trades to be prepared by various members. Sir WILLIAM PETTY's account of woollen manufacture was one of these.

(34) The first charter of July 15, 1662, proving inadequate for the needs of the Society, the second and more important charter passed the great seal April 22, 1663.

(35) This line is omitted in H.P. fo. 120. Theology and politics were forbidden subjects of discussion at the scientific assemblies from 1645 on. See WALLIS, *op. cit.*, p. 7; SPRAT, *op. cit.*, pp. 56, 82-83.

Early Developments in Electromagnetic Theory

With two unpublished letters by ANDRÉ MARIE AMPÈRE

To students of mathematical physics AMPÈRE's contributions to the theory of electromagnetic phenomena in the quasi-stationary state (commonly known today as magnetostatics) are universally recognized as not only of primary importance, but as absolutely essential for the later progress in this field. Without AMPÈRE's work our knowledge concerning the mutual effects between electric currents and magnetic fields would be but a drab assemblage of experimental facts; with it, the subject becomes a fascinating and even inspiring study.

Although these early electromagnetic discoveries are usually passed over in routine teaching as "fundamental principles," a brief examination of the contemporary situation is sufficient to show their significance as a momentous advance in current knowledge. When one has the good fortune to read in the original manuscript the two letters printed below, (1) and looks into the matter enough to understand the questions referred to, it is possible, for the moment, to reconstruct some of the color and enthusiasm of those early days.

The first and perhaps most important step towards the correlation of electric and magnetic phenomena was made by OERSTED. Presented to the scientific world through a Latin pamphlet on July twenty-first, 1820, the report of his experiments was at once translated into French, German, Italian, English and

(1) These letters came into the possession of the Massachusetts Institute of Technology with the Vail Library of electrical engineering, presented to the Institute in 1912 by THEODORE N. VAIL, then President of the American Telephone and Telegraph Co.

Danish. (2) Before that time, such a mutual interaction had long been suspected. More than that, it had seemed almost necessary that a correlation of some form should exist. OERSTED's experiments definitely illustrated some of the effects which were exerted by an electric current (at that time known as *galvanic electricity*) upon a magnetic needle suspended in the earth's field. Before this, numerous experiments had been tried to discover a similar effect by means of a static charge, but the stationary state of course gave no evidence of any correlation whatsoever. The situation was similar to that in which FARADAY some years later tried in vain to discover the effect of magnetically induced electromotive forces in a pair of coils carrying stationary currents and possessing a mutual magnetic field. The latter problem was solved accidentally when one of the currents was in a state of change. In OERSTED's case the effect upon the magnetic needle was found when the " static " charge was in a state of motion, i.e., when an electric current flowed in a neighboring conductor.

Phenomenal as this discovery was, it was, nevertheless, merely an additional fact. It in itself could shed no light upon the nature of or correlation between magnetism and electricity, either in its static or motional form. It was, however, the stroke which gave impetus to an almost world-wide activity that ultimately yielded such a correlation. First among those who successfully carried on these researches was AMPÈRE. How enthusiastically he must have labored with the problem is evidenced by the fact that his first publication on the subject is dated September 18th, 1820, only two months after OERSTED's discoveries had been made known ! This paper was followed in rapid succession by further studies communicated to the Académie royale des Sciences during the following months. (3)

To clearly appreciate AMPÈRE's contributions, however, we must be reminded of the following points. AMPÈRE saw in OERSTED's

(2) *Experimenta circa effectum conflictus electrici in acum magneticam.* A facsimile reprint with reproductions of contemporary translations was issued by the Oersted Centenary Committee in 1920 under the title, *La découverte de l'électromagnétisme faite en* 1820. (See also a facsimile in *Isis*, 10, 437-44, 1928.)

(3) See *Journal de physique*, t. 91, 1820; *Annales de chimie et de physique*, ser. 2, t. 15, 1820; also reprints in *Mémoires sur l'action mutuelle de deux courans électriques* (n.d.), and *Receuil de mémoires, notices... relatifs à l'action mutuelle de deux courans électriques*, Paris, 1822.

experiments more than just a mutual interaction between the two states—magnetism and galvanic electricity. He saw that the former was not at all a separate state but rather a consequence of the latter! He saw that magnetism was not a fundamental phenomenon,—that neither was the force exerted by the current-carrying wire upon the magnetic needle a fundamental phenomenon, but that the force exerted by one current-carrying conductor upon another was the fundamental effect, and that magnetism (or the magnetic field) was merely an intervening state by which the latter effect was invariably accompanied!

AMPÈRE not only saw this clearly but formulated his ideas quantitatively in mathematical language. Without this formulation the experimental evidence had no fabric, no structure, no correlating and stabilizing foundation; with it this evidence was strengthened and the way clearly marked for further progress.

This can all be appreciated quite easily today. But at the time these ideas were first presented they seemed to many almost incredible. In fact, AMPÈRE was for many years kept busy devising apparatus wherewith to demonstrate his contentions quantitatively to a skeptical audience. However, he had also his staunch friends and admirers from the first. Such a one was S. SPEYERT VAN DER EYK, professor of mathematics and physics at the University of Leyden who was inspired to undertake experimental investigations of his own for the purpose of strengthening and defending AMPÈRE's theories. It is the material dealt with in some of these experiments that is the chief subject under discussion in the letters given here.

The memoir to which AMPÈRE refers in the first letter is probably that which Professor VAN DER EYCK published in the " Algemeenen Konst- en Letterbode " of Friday the 11th of May, 1821, (4) in which he reports among other things that a helix or spiral conductor carrying current and suspended in the earth's field will orient its axis in the same manner as a magnetic needle, and that this orientation will be reversed with a reversal of the current. His object there was to strengthen AMPÈRE's contention

(4) The first of a series of contributions appearing in this periodical in 1821 and 1822, and reprinted in part under the title, *Verhandeling over het electromagnetismus*, Harlem, 1823.

that the orientation of the helix was the same as it would be under the influence of a second circular current-carrying circuit whose axis coincided with the magnetic meridian of the earth, and that therefore the earth's magnetism may be attributed to electric currents flowing in the equatorial regions.

Related to these observations is the outstanding theory that the helix referred to above behaves exactly like a magnetized needle and that we therefore may suppose that magnetism is produced in materials by the orientation of elements about which electric currents are continuously circulating. This is the subject discussed by AMPÈRE in the second letter below where he refers to a letter addressed to M. VAN BECK. (5) The " remarkable experiments of Mr. FARADAY " (6) are concerned with the production of a continuous circular motion by a current-carrying wire about the pole of a magnet. The latter experiment and that of M. DE LA RIVE are described in a most interesting manner in DE LA RIVE's " Mémoire sur quelques nouvelles expériences électro-magnétiques et en particulier sur celles de Mr. Faraday."(7)

For the footnotes and other bibliographic aid, I am indebted to Mrs. KATHARINE MAYNARD, Vail Librarian, Massachusetts Institute of Technology.

Massachusetts Institute of Technology ERNST ADOLPH GUILLEMIN.
Cambridge, Massachusetts

(5) *Journal de Physique*, t. 93, pp. 447-67, Oct. 1821; reprinted in *Mémoires sur l'action mutuelle de deux courans électriques*, pp. 169-98, which volume contains also interesting letters from AMPÈRE to ARAGO, DAVY, and DE LA RIVE.

(6) See *Journal of the Royal Institution*, v. 12, p. 74. A description of the FARADAY experiment repeated with AMPÈRE's own apparatus is given in a pamphlet entitled, *Description d'un appareil électro-dynamique construit par M. Ampère*, Paris, 1824.

(7) *Bibliothèque universelle*, décembre, 1821. OERSTED's copy of this memoir autographed by DE LA RIVE is in the Vail collection.

A Monsieur Speyert Van der Eyk,
professeur à la Faculté des
Sciences de l'Académie de Leyde.
A Leyde,
Royaume des Pays-Bas.

Paris, 15 *août*, 1821.
rep. 12 *octobre*, 1821.

Monsieur,

J'étais absent de Paris lorsque le mémoire (8) que vous m'avez fait l'honneur de m'envoyer, et la lettre obligeante dont il était accompagné, sont arrivés chez moi. N'en ayant eu connaissance qu'à mon retour je n'ai pu vous en faire plus tôt tous mes remercîments. J'ai lu avec beaucoup de plaisir ce mémoire. Les faits que vous y décrivez ne peuvent manquer d'intéresser les physiciens. Ils sont, au reste, comme vous me l'annoncez une suite nécessaire de la théorie que j'ai exposée, mais peut-être pas de la manière la plus propre à la faire bien concevoir. Voici comme j'aurais dû la préciser :

1. Toute explication dans les sciences consiste à découvrir un fait primitif exprimé par une loi générale, et qui, une fois posé, serve à en déduire tous les autres.

2. Le fait primitif ne saurait être ici l'action entre un conducteur voltaïque et un aimant, parce que ces deux choses étant hétérogènes, leur action mutuelle est nécessairement plus compliquée que celle qui a lieu entre deux aimants, ou celle que j'ai découverte entre deux fils conducteurs.

3. Comme on n'a connu d'abord que celle entre deux aimants on l'a prise pour fait primitif, et on a pris pour la loi générale à laquelle on a tâché de tout ramener, que les extrémités de même nom d'un aimant se repoussent et que celles de nom opposé s'attirent.

4. Comme l'ordre dans lequel on a découvert les faits ne fait rien à leur réalité dans la nature, j'ai pu prendre pour fait primitif l'action mutuelle de deux fils conducteurs telle que je l'ai établie par des expériences multipliées, et pour loi générale que deux parties de fils conducteurs s'attirent quand la direction de l'extrémité zinc à l'extrémité cuivre, que j'ai nommée pour abréger : direction du courant électrique, est dans le même sens dans les deux portions qui agissent l'une sur l'autre, et que ces deux portions se repoussent quand la direction de l'extrémité zinc à l'extrémité cuivre est en sens contraire dans ces mêmes portions.

5. J'ai représenté par la formule publiée dans le cahier de septembre,

(8) See footnote 4.

1820, du Journal de Physique, ce que devient cette action dans toutes les positions que peuvent avoir l'une à l'égard de l'autre les deux portions de fil conducteur.

6. J'ai d'abord déduit de cette loi toutes les circonstances de l'action mutuelle de deux conducteurs voltaïques, telles qu'on les observe dans mes expériences où l'aimant n'est point employé. J'ai montré par d'autres expériences qu'un circuit voltaïque mobile était dirigé par le globe terrestre précisément comme il le serait d'après les mêmes lois par de l'électricité disposée et se mouvant dans les régions équatoriales principalement comme l'électricité est disposée et se meut dans le fil conducteur de l'extrémité zinc à l'extrémité cuivre, ou bien dans la pile de l'extrémité cuivre à l'extrémité zinc. J'en ai conclu, comme je le devais, que la direction du circuit voltaïque mobile par le globe de la terre devait être attribuée en effet à cette cause, et j'ai ajouté à cette preuve directe plusieurs considérations qui en montrent toute la probabilité.

7. Puis venant à l'action mutuelle d'un conducteur et d'un aimant découverte par Monsieur Oersted j'ai trouvé qu'elle était précisément celle qui aurait lieu si l'aimant était un assemblage de conducteurs ou de piles voltaïques dans des plans perpendiculaires à son axe.

8. J'ai imité complètement tous les phénomènes que présentent les aimants avec des conducteurs roulés en hélices et disposés comme vous avez pu le voir dans mon mémoire.

9. J'ai montré que l'aiguille aimantée était dirigée par le globe terrestre, précisément comme elle le devait être d'après les courants électriques dont j'avais déjà établi l'existence dans le globe, d'après la manière dont ces courants agissent sur un aimant dans les expériences de Monsieur Oersted.

10. Enfin j'ai montré qu'en attribuant tous les effets des aimants à ce qu'il y existe dans des courbes fermées, soit autour de l'axe, soit autour de chaque molécule, la même disposition d'électricité que dans les piles et les conducteurs voltaïques, toutes les circonstances de leur action mutuelle, et celles en particulier de l'aimantation par simple et double touche, s'expliquaient bien mieux que par l'ancienne théorie. J'ai même montré qu'à l'égard de l'aimantation cette théorie était en contradiction manifeste avec plusieurs faits.

Mais cet ensemble de preuves de l'identité de l'électricité et de la cause des phénomènes magnétiques n'a pas encore produit la conviction générale qu'on devait naturellement en attendre. Je ne puis l'expliquer que par une circonstance dont je ne puis d'ailleurs me rendre raison, c'est qu'on a partout répété les expériences de Monsieur Oersted, et que les miennes sur l'action mutuelle des conducteurs voltaïques ne l'ont été à ma connaissance qu'à Paris, à Genève, et peut-être chez vous.

Cependant elles sont bien aisées à faire. Monsieur Thillaie (9) à Paris, Monsieur de La Rive (10) à Genève les ont répétées avec tout le succès possible. Je les ai faites vingt fois en présence d'un grand nombre de personnes parmi lesquelles Messieurs de Humboldt, (11) de Bournon, (12) Fourier, (13) Arago, (14) Fresnel, (15) Dulong, (16) etc. etc. Dernièrement j'en ai montré une partie à Monsieur le docteur Ure. (17)

Je reste convaincu que partout où on les répétera avec un peu de suite on ne pourra se refuser à admettre les conséquences que j'en ai tirées.

Il s'en faut bien qu'on ait besoin pour cela d'appareils dispendieux. Monsieur Thillaie a réussi avec une pile de six couples de 4 pouces sur 6 de grandeur, et avec de simples conducteurs de fils de laiton munies de pointes d'acier pour qu'ils puissent se mouvoir librement en tournant dans de petites coupes pleines de mercure qu'on peut faire de la substance qu'on veut.

J'ai l'honneur d'être avec la plus haute considération,
Monsieur,

Votre très humble et très obéissant serviteur,
A. Ampère.

A Monsieur
Speyert Van der Eyk,
professeur, etc.

Paris, 12 *avril*, 1822.

Monsieur,

J'ai éprouvé un véritable chagrin en recevant votre lettre datée du 15 mars dernier, en voyant que vous m'aviez prévenu dans l'intention où j'étais de vous écrire, et de répondre à la lettre que vous m'aviez fait l'honneur de m'adresser l'année passée. Cette précédente lettre ne m'a

(9) Jean Baptiste Jacques Thillaye (1752-1822), who performed these experiments in his lectures at the Collège de Louis-le-Grand.

(10) Charles Gaspard de La Rive (1770-1834), professor and later rector of the Academy in Geneva.

(11) The German naturalist and explorer, who made valuable contributions to terrestrial magnetism through his scientific expeditions.

(12) Jacques Louis de Bournon (1751-1825), French mineralogist and curator of the Royal collection of minerals.

(13) Jean Baptiste Joseph Fourier (1768-1830), the famous mathematician.

(14) Dominique François Jean Arago (1786-1853), French physicist and astronomer, who made notable discoveries in magnetism and in optics.

(15) Augustin Jean Fresnel (1788-1827), physicist and engineer.

(16) Pierre Louis Dulong (1785-1838), professor and later director at l'École polytechnique.

(17) Andrew Ure (1778-1857), Scotch scientist, and founder of the Glasgow Observatory.

été remise qu'à mon retour à Paris après un voyage dans le midi de la France où j'avais été pour remettre ma santé très délabrée à cette époque. Je trouvai cette lettre en arrivant à Paris avec une de Monsieur Van Beck (18) et une de Monsieur Van der Heyden. (19) Je me proposai

Fig. 1. Letter dated April 12, 1822.

de répondre à toutes trois et je commençai par celle de Monsieur Van Beck, à cause qu'elle contenait une expérience importante pour la confirmation de ce que j'avais lu à l'Académie des Sciences, au mois de janvier, 1821, sur la plus grande probabilité de la manière de considérer les couran(t)s électriques des aimants autour de chacune de leurs particules. Je voulus traiter cette question en détail, y joindre d'autres considérations,

(18) ALBERT VAN BEEK (1787-?), professor at Utrecht.

(19) One of the experimenters mentioned in the *Description d'un appareil électrodynamique* (see footnote 6), as having devised means for demonstrating electromagnetic phenomena.

en sorte que ma lettre à Monsieur Van Beck, commencée le 12 janvier n'a été finie que le 27 mars. J'ai si peu de tem(p)s disponible que je n'ai pas la possibilité de faire la plus grande partie des expériences dont j'aurais besoin. Au reste vous pourrez voir cette lettre dans le Journal de Physique de Monsieur de Blainville. (20)

J'ai mille et mille remercîments à vous faire de l'envoi de votre mémoire, que j'ai lu avec un extrême plaisir. L'expérience de Monsieur de La Rive (21) qui semble au premier coup d'œil ne pas s'accorder avec ma théorie en est au contraire une suite nécessaire, aussi bien que les expériences si remarquables de Monsieur Faraday, (22) et celles que j'ai faites depuis et que vous trouverez annoncées dans ma lettre à Monsieur Van Beck, insérée dans le numéro du Journal de Physique qui paraît actuellement. Ces expériences ont été communiquées à l'Académie aux mois de décembre et de janvier derniers. Mais pour bien concevoir toutes les circonstances de l'expérience de Monsieur de La Rive, il faut faire attention à l'inclinaison que prennent, relativement à l'axe de l'aimant, les couran(t)s électriques qui circulent autour de ses particules en vertu de leur action mutuelle. J'ai depuis longtem(p)s cherché à exprimer cette inclinaison pour chaque particule d'après sa distance à l'axe de l'aimant, et l'endroit de la longueur de cet axe où la particule répond perpendiculairement. Quoique j'aie aisément déterminé le sens de cette inclinaison et les résultats généraux, parfaitement conformes aux expériences, qu'elles doit avoir dans la production des phénomènes, que j'aie même fait graver dans une planche qui doit faire suite à celle de mon premier mémoire, je n'ai encore rien publié à ce sujet faute de tem(p)s, et parce que les calculs que Monsieur Savary (23) et moi avions essayés pour parvenir à une détermination suffisante de la valeur mathématique de l'inclinaison, ne nous ont pas encore donné les résultats que nous en espérions. La seule chose qui ait paru sur ce sujet est une note de l'analyse des travaux de l'Académie Royale des Sciences pendant l'année 1821, par Monsieur Delambre. Je joins ici cette note tirée du commencement de l'article de cette analyse où ce grand astronome rend compte de ce que j'ai fait sur les faits de l'électro-magnétisme pendant cette année. J'ai l'honneur d'être avec la plus parfaite considération,

Monsieur,

votre très humble et très obéissant serviteur,

A. Ampère.

---

(20) See footnote 5.

(21) See footnote 7.

(22) See footnote 6.

(23) Félix Savary (1797-1841), professor of astronomy and geodesy at l'École polytechnique.

J. O. Halliwell and the Historical Society of Science (London 1841)

As historians we are interested in the history of Societies that have been founded to promote the investigation and study of science and as Members of the History of Science Society we are interested still more in Societies that have or have had the same aims as our own.

Few persons are aware that our Society had a forerunner in England in the first half of the 19th century and although the Society in question lasted a very short time, yet some account of it may well be allowed to occupy a few pages of our journal. The Society we refer to was the Historical Society of Science founded in 1841 by JAMES ORCHARD HALLIWELL a remarkable man who although he had only then attained his majority, had already a record of achievement behind him.

Before proceeding to details attention may be directed to the remarkable outburst of interest in history and archaeology that took place in England in the eighteen forties. The day of " Bill Stumps his mark " was passing and in its place the subjects in question were being approached scientifically through the study of documents and through excavation. The period was also a fruitful one for the founding of purely scientific bodies. The rapid growth in material wealth did much to encourage this outburst. We see the same factor producing similar effects in the United States of America in recent years—indeed periods of advancement of learning are usually associated with periods of material prosperity. The list given below of Societies founded in the forties is not complete but is a sufficiently striking one. It is satisfactory to know that many of them still flourish.

Camden Society, 1838 (absorbed in 1897 into the Royal Historical Society).

Shakespeare Society, 1840 (subsequently re-founded).

† Percy Society, 1840.

† Grainger Society for the publication of ancient portraits and family pictures, 1841.

† Ælfric Society for the illustration of English History and Philology, 1842.

† Wycliffe Society for the publication of... the most important... writings of the early reformers... 1843.

Chetham Society, 1843.

British Archaeological Association, 1843.

† Cabot Society, 1845.

Archaeological Institute of Great Britain and Ireland, 1845.

Hakluyt Society, 1846.

† Arundel Society, 1848.

There were other Societies 'devoted to Science' founded in the same decade :

Royal Botanic Society, 1839.

Royal Microscopical Society, 1839.

Chemical Society, 1841.

Ethnographical Society, 1843 (merged into the Anthropological Institute of Great Britain and Ireland).

Ray Society, 1844, for publication of works of natural history.

† Wernerean Club, 1844, to encourage scientific research.

† Palaeontographical Society, 1847.

Institution of Mechanical Engineers, 1847.

The Historical Society of Science was, like the Camden Society on which it was modelled, essentially a publishing society. The moving spirits were HALLIWELL, who was Secretary and Treasurer, and THOMAS WRIGHT, his life-long friend, who figured on the Council. The prospectus was issued in June, 1840 and the aims of the Society were succinctly set out as under :

"THE HISTORICAL SOCIETY OF SCIENCE.

The object of the Historical Society of Science is to render materials for the history of the Sciences accessible to the general reader, by the publication of manuscripts, or the reprinting of very rare works connected with their origin and progress in this country and abroad.

† With the exception of those marked thus, the Societies survive.

The plan adopted for carrying this purpose into effect is by an annual subscription of One Pound from each Member, such Member being entitled to one copy of each of the works published by the Society.

The number of Members is limited to Six Hundred, and, until the limit is attained, Members are admitted on the introduction of one of the Council, or by application to the Secretary."

With HALLIWELL and WRIGHT were associated on the Council many distinguished men :

CHARLES PURTON COOPER, Q.C., D.C.L., F.R.S., F.S.A.,

THOMAS STEPHENS DAVIES, F.R.S.L. & E., F.S.A., *Professor of Mathematics at the Royal Military Academy, Woolwich,*

AUGUSTUS DE MORGAN, V.P.R.A.S., *Professor of Mathematics at University College, London,*

Rev. JOSEPH HUNTER, F.S.A., F.R.A.S., *Assistant Keeper of H.M. Records,*

Sir FRANCIS PALGRAVE, K.H., F.R.S., *Deputy Keeper of H.M. Records,*

THOMAS JOSEPH PETTIGREW, F.R.S., F.S.A., F.L.S.,

Rev. BADEN POWELL, M.A., F.R.S., *Savilian Professor of Geometry, Oxford,*

Sir J. GARDNER WILKINSON, F.R.S., M.R.S.L., F.G.S.,

Rev. ROBERT WILLIS, M.A., F.R.S., *Jacksonian Professor of Natural Philosophy, Cambridge,*

JAMES YATES, M.A., F.R.S., F.G.S.

Apparently a meeting was held in June to constitute the Society and HALLIWELL must have been very active, for shortly after a leaflet of 8 pp. 8vo was issued, showing on the front page that the Society had blossomed out, with an imposing list of names. The President was H.R.H. The DUKE OF SUSSEX (who was the President of the Royal Society) and there were six vice-presidents who, however distinguished otherwise, could only have had a slight interest in the history of science. They were :

Rt. Hon. The EARL OF MUNSTER, F.R.S.,

Rt. Hon. LORD HOLLAND, F.R.S.,

Rt. Rev. the Lord Bishop of Durham, F.R.S., F.S.A. (EDWARD MALTBY, D.D., 1770-1859),

Sir ROBERT HARRY INGLIS, Bart., M.P., LL.D., F.R.S., *Trustee of the British Museum,*

Sir GEORGE T. STAUNTON, Bart., M.P., D.C.L., F.R.S.,
Rt. Hon. Sir LANCELOT SHADWELL, M.A., *Vice Chancellor of England*.

On p. 2 of the leaflet the rules of the Society are given and are worth quoting.

"LAWS OF THE HISTORICAL SOCIETY OF SCIENCE

1. That the Society shall be entitled the "HISTORICAL SOCIETY OF SCIENCE."

2. That the object of the Society shall be the printing of early and other documents illustrative of the history of the sciences at home and abroad.

3. That the Society shall consist of six hundred Members, being subscribers of One Pound annually; such subscription to be paid in advance on or before the first Monday in June in every year.

4. That any Member of the Society may at any time compound for his future annual subscriptions, by the payment of £10 over and above his subscription for the current year.

5. That the affairs of the Society shall be managed by a President, six Vice-Presidents, and a Council of twelve Members, (nine of whom shall be re-eligible) including a Treasurer and Secretary, which Council shall be elected at the General Meeting to be held on the first Monday in June.

6. That the accompts of the receipts and expenditure of the Society shall be audited annually by three Auditors, to be elected at the General Meeting.

7. That the funds of the Society shall be disbursed in payment of necessary expenses incident to the production of the Works of the Society, and that all other expenses shall be avoided as much as possible.

8. That every Member not in arrear of his annual subscription, shall be entitled to one copy of each work printed by the Society."

Following these "Rules," two works by the indefatigable promoters are described as being in the press. The published titles are as follows :

HALLIWELL, J. O. A Collection of Letters illustrative of the Progress of Science in England from the Reign of Queen Elizabeth to that of Charles the second, London, R. and J. E. Taylor, 1841. 8vo cloth. Printed for the Historical Society of Science.

WRIGHT, THOMAS, M. A., F. S. A. Popular treatises on science written during the Middle Ages in Anglo-Saxon, Anglo-Norman and English..... London, R. and J. E. Taylor, 1841. 8vo cloth. Printed for the Historical Society of Science.

There follows an interesting list of 12 "Works suggested for publication," few of which have even yet been printed :

Treatises on Geometry written in England during the 13th and 14th centuries; including an hitherto inedited treatise on that subject, by ROGER BACON.

Treatises on the theory and practice of music, of the fifteenth century. From a MS. in the Lansdowne collection in the British Museum.

An English treatise on Algorism, or Arithmetic, of the fourteenth century. From a MS. in the Ashmolean Museum at Oxford.

The preface to the Seventh Book of the Mathematical Collections of PAPPUS ALEXANDRINUS, in the original language; with an English translation, and explanatory notes.

An English tract on the making of oils and medicinal waters, from a MS. of the fourteenth century.

Proposals for mechanical inventions addressed to Queen ELIZABETH by WILLIAM BOURNE, "Master of the Gravesend Barge." From a MS. in the British Museum.

A catalogue of the scientific manuscripts formerly in the library of Dr. JOHN DEE of Mortlake. From DEE's own catalogue in the British Museum.

A collection of early tracts on the method of illuminating, and on the materials employed in that art.

A collection of early tracts on the practice of lithotrity.

Anglo-Saxon tracts of the tenth century on Botany and Natural History, with an account in Anglo-Saxon of the wonders of the East; together with some middle-age treatises on the same subjects, and a selection of figures of animals and plants from early manuscripts. To be edited with translations.

An original journal of EDWARD FENTON's voyage to St. Helena in the year 1582, interspersed with scientific observations and notices of English science.

A description of the Merva, a mechanical instrument invented by SIMON STURTEVANT of Christ's College, Cambridge; from the autograph manuscript dedicated by the inventor to JAMES I. To which will be added biographical notices of STURTEVANT, and several hitherto inedited letters and documents.

A collection of early tide tables, including a series made by JOHN MARSHALL, temp. ELIZABETH.

On pp. 5-9 of the leaflet is given a list of Members numbering 179.

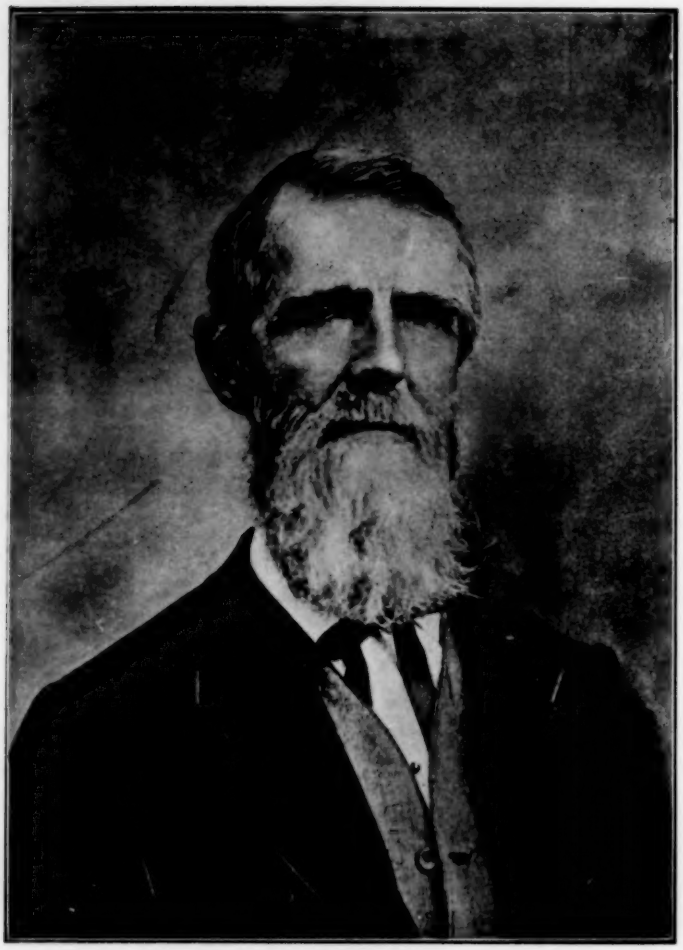
An auspicious start, we would say, for a young man of twenty one to have made! But sad to relate, this was all the Society did and it came to an end within the year, whether because support was not forthcoming, or whether HALLIWELL had too many irons in the fire, or whether his mind had begun already to run in the literary direction that was to be his life's work rather than on the scientific lines upon which he had begun.

HALLIWELL, as will be inferred, must have been precocious. He was the third son of THOMAS HALLIWELL who had come to London in 1795 and prospered in business. James was born in Sloane Street, Chelsea, 21st June 1820 and his precocity is shown by the fact that when a mere boy he had a passion for collecting MSS., then to be had for a mere song. He must have been able to a large extent to evade the school curriculum.

Nowadays with every hour of a boy's time earmarked it would be very difficult to do as he did. He matriculated from Trinity College, Cambridge, 1837, but migrated the following year to Jesus of which College he became Librarian. He published in 1838, *Life and Writings of Sir Samuel Morland* and in the following year he edited Sir JOHN MANDEVILLE's *Travels*, and *Rara Mathematica*, a collection of early treatises. In 1840-1 he edited no fewer than 23 works, including his earliest Shakespearean studies. He edited works for the Camden Society, 1839-44, the Percy Society, 1842-50, and the Shakespeare Society. He was on the councils of the Camden, Percy, Shakespeare and Grainger Societies. His scholarship was remarkably mature and has been little criticised since. He was elected a F.S.A. 14th February, 1839 and a F.R.S. 30th May, 1839. On 9th August, 1842, he wooed and won against her father's wishes HENRIETTA, the daughter of Sir THOMAS PHILLIPPS. Such was his brilliant start, when in 1844, a bookseller with whom he had had dealings offered to the British Museum some MSS. which had been purloined from Trinity College, Cambridge. HALLIWELL declared that he had purchased them and his friends believed him, but the Director of the Museum 10th February, 1845, forbad him to enter the Library. It made little difference to his chequered and wayward career into which it is unnecessary to go further from our point of view, except, however, to mention that he assumed the name of PHILLIPPS on the death of his father-in-law in 1872 when he inherited under his will. It may be mentioned as showing his prolific literary output that the entries of his works take up no less than 17 pp. of the British Museum MS. Catalogue. His monument is his work on SHAKESPEARE, his purchase of New Place for the nation and his establishment of the Shakespearian Festival.

In his later years he built a quaint rambling wooden house at Hollingbury Copse on the downs above Brighton and adorned it with inscriptions from his favourite author such as : " Come hither, come hither, come hither, here shall ye see no enemy but winter and rough weather." *(As you Like it.)* He died here 3rd January, 1889, in his sixty-eighth year.

H. W. DICKINSON.



H. W. RAVENEL at the age of 70.

(By courtesy of Dr. W. C. COKER)

UNIV OF

The Mycological Work of Henry W. Ravenel.

During the middle half of the last century there were accumulated in this country two notable collections of fungi, that of M. A. CURTIS, now part of the Farlow Herbarium at Harvard, and that of HENRY W. RAVENEL, now in the British Museum. Information regarding the lives and methods of work of these pioneers of American mycology is none too abundant, even though they lived and worked so recently. From a mass of hitherto unpublished material regarding RAVENEL, have been selected here those items which bear particularly on the development of his mycological interest, the handling of his herbarium and the preparation of his exsiccati. Some of this material comes from letters to fellow botanists but the most important source is RAVENEL's voluminous, though not complete, diary, now in the possession of his daughter, MARY RAVENEL of Aiken, South Carolina. A typewritten copy of the contents of the existing volumes has been made by Miss EMMA RICHARDSON, Secretary to the Director of the Charleston Museum. This copy has been deposited in the Charleston Museum and forms a valuable source of material which no student of the history of South Carolina from 1860 to 1885 can afford to overlook, particularly since historical records are none too abundant in that state. In the words of a student of a critical period in the history of South Carolina, " she has been as backward in preserving records as she has been forward in furnishing acts worth recording."

Early Life and Education

The main facts regarding the life of HENRY W. RAVENEL have been presented elsewhere. He was born on the " Pooshee " plantation in St. John's Berkeley Parish, South Carolina, May 19,

1814, graduated from the South Carolina college in 1832, and settled in St. John's as a planter. In 1853, he removed to Aiken, South Carolina, where he spent the remainder of his life, and died July 18, 1887.

Dr. HENRY RAVENEL of Pooshee, father of HENRY W. RAVENEL, was of pure Huguenot descent. The record of his ancestry for four generations shows no trace of other blood and includes the well known Huguenot names of DE ST. JULIEN, LE SERRURIER, LE NOBLE, and MAZYCK. He studied medicine first in Charleston with Dr. SAMUEL WILSON and later in Philadelphia. He practiced medicine for a decade or more but gave it up about 1824. Following this he took up planting with great vigor. As a planter his success was such that he became a marked man in his community. To his inherited acres he added many others until he owned plantations bordering on the public road above and below Pooshee for a distance of fourteen miles, with a break of only a few hundred yards where a corner of the Wantoot lands comes to the Black Oak Road.

RAVENEL's mother, CATHERINE STEVENS, was also in part of Huguenot descent. Her mother was CATHERINE RICHBOURG, descendant of the Reverend CLAUDE PHILIPE DE RICHBOURG, pastor of the Huguenot Church on the Santee. CATHERINE STEVENS' father was O'NEAL (also spelled Oneal and O'Neil) GOUGH STEVENS. He was born about 1767 and was the only son of JACOB STEVENS and MAY GOUGH (STEVENS). JACOB STEVENS was an indigo planter on the Santee. HENRY WILLIAM RAVENEL was barely two years old when his mother died.

When he was six years old he began school at the Pineville Academy. This famous grammar school was at this time (1820) near the zenith of its prosperity and influence. In January 1829, then in his fifteenth year, he went to Columbia, South Carolina, to school to Mr. JAMES M. DANIELS, who had taught the year before at the Pineville Academy. In October, 1829, he entered the sophomore class of South Carolina College, and in December, 1832, graduated with the degree of A. B. Of his college course and his subsequent decision to take up planting RAVENEL writes in his diary as follows :

" After graduating at College, where I idled the first 18 months of

my course, and made some amends in the last year, studying pretty hard and taking one of the high appointments, I came home intending to study medicine, and did really begin to read a work on Physiology. My father, who had practiced in the country and had to give it up on account of ill health, dissuaded me from it as too arduous a work for my constitution, thinking only of a hard country practice, and not estimating the advantages which I might have acquired from a knowledge of Anatomy, Physiology and Therapeutics."

He also notes that while in college he " paid much attention to Chemistry and Natural Philosophy and was pleased with this glimpse of the world of Nature."

In connection with this somewhat casual reference to his college studies in natural science it should not be forgotten that through the influence of THOMAS COOPER, an unusual amount of attention was given to natural science at the South Carolina College. It was at this time the only college in the country except Yale which offered a course in geology.

Early Botanical Work

By the time HENRY W. RAVENEL was twenty-two he was established as a planter. He had married in December 1835, ELIZABETH G. SNOWDEN. He was the owner of the beautiful " Northampton " plantation, which, with slaves sufficient for its cultivation, had been given him by his father. He had received the best education his native state afforded. There was no reason why he should not become a successful planter, but there was as yet nothing to indicate that he would become one of the few outstanding American botanists of his time.

The first evidence of RAVENEL's interest in science appears in his connection with the " Black Oak Agricultural Society " which was formally organized on February 10, 1842 and of which he was the first secretary and treasurer. Before the society he read several scientific papers, notably one on the subject of meteorology in its connection with agriculture. In this he discusses the relation of meteorology to agriculture with special reference to the work being then done in England, and closes with an incisive defense of the accumulation of apparently useless scientific information.

RAVENEL began serious botanical work about the time of the formation of the Black Oak Agricultural Society (1841 or 1842), when he was twenty-five or twenty-six years old. The incident which fixed his attention on botany was an apparently trivial one which he recorded in his diary some twenty-five years later (July, 1866).

"I had a visit from a traveling naturalist, a Mr. Olmstead who was collecting plants. He initiated me fairly in the mode of making collections, and so interested me in the subject that I commenced then to collect and study. At the end of the first season I had made a very respectable beginning. My house at Northampton was burned down the following winter and all my collection destroyed. I began anew in the spring and with the aid of Doctor Bachman at first, and then afterwards of Doctor Curtis, Professor Gray and others, continued the recreation. About 1846 I commenced the investigation of Cryptogamic botany, and made much progress in my collection, having the correspondence and aid of Doctor Curtis and Mr. Berkeley on the fungi, of Tuckerman in the Lichens and Sullivant in the Mosses."

The "traveling naturalist" here referred to was probably CHARLES HYDE OLMSTEAD, 1798-1878, of East Hartford, Connecticut, a wealthy bachelor with a strong liking for collecting plants and books, who is known to have made a botanizing trip in the southern states at about this time. There is, however, no indication that he and RAVENEL had any further correspondence.

Previous to this visit of OLMSTEAD's to which RAVENEL himself refers as the starting point of his serious botanical work, he had of course had some "fondness for botany" and had made a few collections of plants and fossils. Living in a region characterized by so rich and varied a flora as is that of St. Johns, it is not surprising that such an impulse as OLMSTEAD's visit should have served to change his casual interest in plants into a serious study of plant life.

Two notable botanists, THOMAS WALTER and JAMES MACBRIDE, had already found their inspiration in this region. It is highly probable that some stories of the popular physician and enthusiastic botanist, JAMES MACBRIDE, who died when RAVENEL was three years old, were still current in Pineville during the years in which, as schoolboy and young man, RAVENEL spent a large part of

his time in that village. With THOMAS WALTER, RAVENEL's connection was even more direct, for his close friend and companion on many botanizing trips was Mr. WALTER PEYRE who lived on the next plantation, Brunswick, and who was a descendant of THOMAS WALTER.

Naturally enough RAVENEL's earlier botanical work was chiefly on the flowering plants, and he was from the first essentially a field naturalist. In 1850 he wrote to EDWARD TUCKERMAN,

" I am endeavoring to get together the whole Flora of this locality, for I think it would be interesting for comparison with other regions, and for exhibiting the great diversity of vegetation, which may find subsistence upon a limited section of country—My labors are consequently more in the woods than in the closet—I love to follow them in their haunts, in the deep forests watch their development, and then to study their ' ways '."

His field experience and interests developed in him something of that patronizing attitude toward the laboratory and herbarium worker which all acquire whose work is largely in the field. To this feeling he gives good-natured expression in another letter to TUCKERMAN written in April, 1858.

" This ' acquired instinct ' or whatever else it may be called, which collectors acquire from the habitual observation of Plants in their natural habitats, may sometime lead to error, but it is oftener correct

Apropos. Several years ago when I first began to collect, I found this Pinus glabrus of Walter and at once recognized it as distinct from P.Mitis Mxi. I sent it, among other plants, to Professor Gray and also to Doctor Curtis for their opinion. They both returned the specimens marked ' Pinus Mitis Mx.' I was silenced for a time, but not convinced for I could not venture to brave the opinion of these veteran botanists. However, in a year or two after Doctor Curtis paid me a visit and on my pointing out the tree, he gave up the point at first sight."

The climax of his work on flowering plants was reached in a paper read before the American Association for the Advancement of Science at Charleston, South Carolina, in 1850. In this paper he lists as having been found within the area to which he was devoting his time 1075 species of flowering plants belonging

to 474 genera, and 1338 species of Cryptogams. Of special interest to students of his specimens is the statement made in the introduction of this paper as to the exact region in which most of his collecting up to this time was done.

"The section of country to which I allude is in the vicinity of the Santee Canal, St. John's (Berkeley) Parish, S. C. The plants have been collected mostly in the neighborhood of Black Oak, and between that place and Cooper River, eight or ten miles South. My excusions have occasionally led me as far as the Santee Swamp, ten or twelve miles North, and some few in my catalogue have been found only at Eutaw Springs, twenty miles North-West. Probably nineteen-twentieths of the Phaenogamous plants have been found within the first named limits, and with very few exceptions, all the Cryptogamia."

The Santee Canal here referred to was begun in 1792 and completed in 1800. It connected the Santee and Cooper Rivers and was, of course, designed to facilitate transport of the produce of the plantations to the port of Charleston. It appears never to have been a success financially, but it forms a wonderful collecting ground and one which, because of RAVENEL's work on fungi, will remain classic for mycologists.

Studies of Fungi

Although RAVENEL's earliest botanical work dealt with the flowering plants, and he retained interest in them throughout his life, it was to the fungi that his best energies were devoted and it is on his studies in this difficult and too often neglected group of plants that his fame as a botanist chiefly rests. As he states in his diary, RAVENEL took up the critical study of fungi about 1846 and during this year began the correspondence with M. A. CURTIS which was to play so large a part in his botanical life, and which was of such benefit to botanical science in America.

MOSES ASHLEY CURTIS was born and educated in Massachusetts. Most of his adult life, however, was spent in the Carolinas and here his botanical work was done. In 1835 he was ordained in the Episcopal Church and began missionary work in western North Carolina. For nine years (1847-1856) he was pastor of the church at Society Hill, S. C., about seventy-five miles north

of RAVENEL's home at Black Oak. For three years before coming to Society Hill, CURTIS was pastor at Hillsboro, N. C. On leaving Society Hill, he returned to the church at Hillsboro and lived at that place until his death, which occurred in 1872.

Among the scattered letters now remaining of RAVENEL's voluminous botanical correspondence are a few from CURTIS. One of these which is dated at Hillsboro, N. C., September 17, 1846, is marked in RAVENEL's handwriting, " Doctor CURTIS' first letter to me." In this letter, CURTIS speaks of being in correspondence with SULLIVANT and TUCKERMAN, and mentions several books which RAVENEL would find useful in the study of fungi. CURTIS further states that he has already secured the assistance of BERKELEY " the finest mycologist in Great Britain," and concludes, " Like yourself, I am now directing attention to the Cellulares, principally to the fungi, but endeavoring not to overlook any of the Musci, Hepaticae, or Lichens." Although it is probable that RAVENEL and CURTIS had met at a much earlier date (1835) their close personal friendship apparently developed from their joint botanical labors which began with this letter. For a period of over ten years they were in almost weekly communication.

As early as 1850 RAVENEL, as well as CURTIS, was sending fungi to the Reverend M. J. BERKELEY for identification. BERKELEY was at that time the leading mycologist of Great Britain, and, as is well known, named a great many fungous species from material collected by the two Americans.

Another correspondence of great importance and value was that with EDWARD TUCKERMAN of Amherst, Massachusetts, which began in 1848. RAVENEL's letters to TUCKERMAN have been preserved almost complete and are a source of information about RAVENEL, second only to his diary. Concerning his botanical correspondence during the period of his greatest activity in the collection and study of fungi, RAVENEL writes as follows in his diary under date of March 25, 1861.

" Received letters today from two of my old botanical correspondents, Curtis and Peters. Since I have withdrawn from active botanical exercises my correspondence has begun to flag. With Doctor Curtis I have been in intimate correspondence since 1843 or 4. For many years (8 or 10)

our letters were rarely more than a week unanswered, and freighted as they usually were with our new collections of fungi, were full of interest. I look back to that period of my life with much gratification. We were both also in correspondence with Berkeley of England, who examined our plants and assisted us in naming and describing them. I was also in correspondence with Sullivant of Ohio to whom I sent my Musci and Hepaticae, afterwards with Lesquereux of Columbus. With Tuckerman I still keep up the correspondence and I expect from him this spring the IVth Fascicle of his ' Lichens Exsiccate ' made up altogether of southern species and mostly of my collection.

Peters has aided me very much in his collections of Alabama fungi, which I have used in my ' Exsiccate.'

I still keep up a casual correspondence with some of my botanical friends ; and with Doctor Curtis, our epistolary intercourse has grown into a personal friendship and attachment. He has three times visited me, once at Northampton and twice here (Aiken, S. C.). I went up once on a visit to him when he was living at Society Hill in this State in March, 1843."

During this period the two friends, RAVENEL and CURTIS, were the only workers in all North America with a critical knowledge of the fungi. TUCKERMAN was, of course, devoting himself with distinguished success to the study of lichens but at that time a hard and fast line was maintained between " lichens " and true " fungi." As a result, while there was an almost continual interchange of letters and specimens between TUCKERMAN and the two Carolina botanists, TUCKERMAN's determinations of lichens were always accepted without question, nor did he make suggestions about " fungi." Each of these workers makes regretful mention of their isolation and of the fact that where the harvest was so very great the laborers were so few.

Looking back upon the period after three quarters of a century it is easy to see that there were compensations. The very fewness of the workers drew them nearer together. For them, as for TORREY and SCHWEINITZ in an earlier generation, botanical correspondences developed into personal friendships. Letter writing became not a task but a joy, with the almost inevitable result that it became a fine art. The raids incident to the War between the States have resulted in the destruction of practically all of RAVENEL's correspondence, but from such fragments of

it as remain, as well as from the letters received by TUCKERMAN, we can readily picture the eagerness with which these letters were anticipated, the joy with which they were received, and the satisfaction with which they were read and reread.

In spite of the notable work of LEWIS DAVID DE SCHWEINITZ, mycology in America was at this time still in the pioneer stage, a fact fully recognized by RAVENEL as indicated in several letters to TUCKERMAN from which the following quotations are taken.

May 17, 1856. "We are all but pioneers in the present state of knowledge, and must be content to do the work of Pioneers in collecting together the materials upon which they who come after us, may be able to build with more success and permanence."

August 5, 1856. "I cannot afford to devote much time to their (the lichens) study, for these fungi of ours, whose name is Legion, are more than enough to occupy me. Indeed I feel at times overwhelmed with the vastness of the field in which we are exploring—To give them anything like minute and accurate study such as they must finally receive when the work is apportioned out to various co-laborers (as it now is in the other departments of botanical investigations) is simply impossible.

I look upon our work at present in this light.—Here is a most untrod, almost unexplored wilderness of new and strange forms—a field white for the harvest. Shall we stroll over these grounds, gather what we can, and arrange and assort as best we may, leaving to those who come after us the task of rearranging and (doubtless) of correcting our many errors—or shall we occupy only a little corner with more close inspection, and leave the great field beyond entirely out of sight? I believe we have adopted the right course (I am alluding to those of us who have attempted the mycological enterprise). The first step is, doubtless, to gain as large a view of the field before us as possible—and then to take in a general aspect of our Mycetose vegetation.

It has fallen to our lot (and I believe it is as honorable a part as any other) to be the pioneers in this work—to clear the way in advance for those who will come to the task with fewer impediments and with the aid which they may derive from our labors."

The zeal and success with which RAVENEL addressed himself to the collection and identification of fungi between 1846 and 1856 is abundantly attested by the large number of specimens collected by him which are to be found in the herbaria of BERKELEY, CURTIS, MICHENER and others. In 1858, when his herbarium

was deposited in the Charleston Museum the fungous collection consisted, according to his own record, of some forty volumes. The circumstances governing this loan as well as the subsequent return of the herbarium to RAVENEL when Federal forces threatened the city are recorded in several entries in the diary during 1862.

" *August* 26, 1862. I wrote yesterday to Dr. William Hume to ask if he could get my herbarium from the Museum in Charleston, and send it up to me. I feel some anxiety at its being exposed to the depredations of our enemies, should they be successful in reaching Charleston.

September 4, 1862. Received today from Charleston five boxes containing my Herbarium of Fungi which have been in the Charleston Museum since 1858. They consist of 40 volumes (of uniform size) together with two larger volumes containing Trogs collection in Switzerland, sent to me by Lesquereux. They need over-hauling and examining and I will keep them here until the war is over. They were not given, but only deposited in the Museum, subject at any time, to be re-claimed by me.

May 13, 1863. I have been engaged for two or three weeks past in overlooking my herbarium of Fungi, and re-poisoning the specimens. It had been in the Charleston Museum for three or four years until I had it sent up last summer. I have now only my herbarium of Phaenogamous plants left in the Museum."

It is perhaps significant of his greater interest in the fungi that at first he sent only for this part of his herbarium. Later, however, the flowering plants were packed up and shipped to Aiken.

RAVENEL's first contribution to the study of American fungi was his " Fungi Caroliniani Exsiccati," a set of five volumes of named specimens of fungi. CURTIS and RAVENEL apparently planned to publish this set together but before the actual work of preparing the volumes began CURTIS withdrew for reasons which appear in his letters to RAVENEL during February 1852, which are here quoted in part.

" *Feb.* 9, 1852. What do you say to taking Fung. Carol. off my hands, and issuing it by yourself, I giving you what stock I have myself gathered, say 25-30 species? The more I think of the business, the more averse I become to it. The amount of labor and time required is more than

I wish to expend in that direction. It is only lately, that I began to make some estimate of it. I wish very much that you would let me off. I will still aid you to some extent in determining species, besides furnishing specimens.

Feb. 18, 1852. I am glad to find you willing, if need be, to release me from the partnership in Fung. Exsico. I had not, until lately, considered the amount of time requisite to carry out the purposes of such a work. I really cannot properly spare the time for it. And besides, there is a very common feeling that such employment is not the proper work of a Clergyman. The feeling I have little respect for, but it nevertheless imposes some necessity upon me to save appearances, and not injure myself by a needless violence to prejudice and ignorance."

Regarding the plan of his " exsiccati " RAVENEL wrote BERKELEY as follows, on April 2, 1852.

" My friend Mr. Curtis has proposed to me to issue in Fasciculis, our Fungi exsiccati Caroliniani, in a similar style to your own and other like works.—He had intended to unite with me ; (and indeed, it was first at his suggestion that the scheme originated) but his numerous and pressing avocations demand too much of his time for such labours.—I have consented to go on, relying, as I must in a great measure, upon your kind assistance in the determination of doubtful species—and hoping by this means to furnish to European Botanists an opportunity of examining and comparing species, and in this manner aiding in illustrating our American mycology.—I have all the matter for Fasc. 1st now ready (to contain 100 species) and I hope to have it out by June or July.—I shall endeavour to have about one half, of species peculiarly American—The first issue will consist of about 30 numbers—the other vols will follow as soon as matter is sufficiently collected for their issue.—

I have excluded all the unedited species of B. & C. and B. & R.—of these I have very copious supplies, which will enable me to proceed immediately with another Fascicle as soon as you publish those species.

Will you be kind enough to aid me in this matter by extending a notice of my intended project in any manner you may think proper through your Botanical magazines.

The publisher to whom application may be made for copies, is *Mr. John Russel, Charleston, South Carolina.*

As you are familiar with the execution of such things, I shall be obliged to you for any suggestions you may think proper to make, as to the cost per vol. of 100 species &c &c.—"

During the preparation of the " Fungi exsiccati " which was the subject of so much interest and correspondence RAVENEL visited Philadelphia and there spent some time in the study of the herbarium of LEWIS DAVID DE SCHWEINITZ, the first great student of American fungi. Of this visit he wrote BERKELEY on August 31, 1853.

" I made a short tour in the early part of the summer to our Northern States, and had the opportunity whilst in Philadelphia, of examining the herbarium of Schweinitz, and, by permission of the Ac. Nat. Sciences, of selecting specimens of Schweinitz's species whenever they were sufficiently abundant.—I was enabled to obtain near 150 authentic species in this manner which will be valuable to me for reference."

RAVENEL's " Fungi Caroliniani Exsiccati " is the first published series of named specimens of American fungi ever issued, and it was designed as RAVENEL states in the letter to BERKELEY, already quoted, " To furnish European botanists an opportunity of examining and comparing species." The set is in five volumes, each containing one hundred specimens, with a systematic index. Volume five contains an alphabetical index of the whole series. Only thirty copies were issued and complete sets are now very rare. CURTIS aided in the determination of species but most of the fungi were collected by RAVENEL himself and he did the work of preparing the volumes.

The first volume was issued in 1852, the second in 1853, the third and fourth in 1855, and the last in 1860. Fortunately, before the last volume of this set of fungi was issued RAVENEL had begun a diary in which he made almost daily entries, so we have an intimate and detailed picture of his method of work. During January 1860, we find the following entries,

" *January* 13, 1860. Employed the day in various work. I completed the index to my fifth Fascicle Fungi Exsiccati, which I commenced day before yesterday. In my absence since October the rats got into my packages and tore up several bundles. I have been able to identify most of the species picked out of the shreds of paper, but one package is too much injured to be used. The fifth fascicle will complete my labours on this work.

I had intended to stop with the fourth but Curtis, Peters, Berkeley and other friends have urged me to go on.

January 14, 1860. I have been employed very much today in preparing the index to the whole of my work, all five fascicles, to be appended to the fifth. This is a troublesome and laborious work. I wish to add a general index, as it is probable this fifth fascicle will be the last I shall issue.

January 16, 1860. Have just completed the General Index to my five fascicles, heavy troublesome work. I hope soon to have it in the printer's hands. I have been busy all day, writing and trimming vines, varying my occupation from one to the other for rest."

After the material was sent to the printer there was the usual interchange of proofs.

"*March* 29, 1860. Delivered package of Lichens to the Adams Express, for Tuckerman. Received from Walker and Evans the corrected proofs of my 'Fungi' and have written a letter to Doctor Curtis enclosing them for his examination."

Sometime before the middle of May the printed and bound volumes were received from the publishers and the work of inserting the specimens began. For almost a month there are constant entries regarding this work, two of which are quoted in full.

"*May* 22, 1860. Occupied at intervals on my fungi.—My books and plants are all spread out on my table in my study and I work for a while until tired, and leave them just as they are to return and resume the work where I left off. I always begin at the end of the volumes and place the 100th species in first, in each of the 30 volumes, then the next, and so on, working back to No. 1. I find this is the best plan and have followed it in all my Fascicles. I gum down about four species a day, in all, making 120 species; and of each species there are from one to three or four specimens each of which requires handling.

These, together with the labels, make sometimes 4 to 500 different objects handled in the getting in of four species.—I have 100 species in each fascicle, so it is no light work to get one set ready for distribution.

June 16, 1860. I have just completed the last number of Fasc. V.

' Fungi Caroliniani Exsiccati ' and I sit down joyfully to record the fact. I commenced the work of laying down specimens on 17th of May having been occupied with it for four weeks and two days. This is probably the last I shall issue, as I do not make collections now, and have been obliged to discontinue the use of the microscope."

Mycological Work after the War between the States

For RAVENEL, as for almost every loyal southerner, the war between the states changed everything. The collapse of the Confederacy left him with his estate seriously impaired, a large family to support, and without regular income. In these circumstances, RAVENEL turned naturally enough to his horticultural and botanical interests as a source of income. He tried shipping peaches and grapes via boat from Charleston, and even experimented with asparagus. He sold, a bit at a time, his valuable botanical library accumulated at great expense and trouble during the years 1846 to '60. He collected seeds for Doctor HOOKER of the Royal Botanical Gardens, Kew, and for the then newly organized United States Department of Agriculture. Most important of all from the standpoint of mycology, he made, in April and May, 1869, a trip to Texas in connection with the expedition sent out to study the Texas cattle fever, sold certain sets of his duplicate fungi and, finally, in collaboration with M. C. COOKE, issued a second set of exsiccati. RAVENEL's experience in practical horticulture and his familiarity with fungi would have given him an outstanding place among plant pathologists had that branch of botanical science been developed to any extent. In that connection there should be noted a reference in his diary to correspondence with Professor W. H. BREWER, newly appointed Professor of Agriculture, in the Sheffield Scientific School of Yale, which, at that time, was receiving the benefit of the fund established by the sale of the landscrip donated to Connecticut for the establishment of an agricultural college.

" *July* 3, 1866. Received a letter yesterday from Prof. W. H. Brewer of the Scientific School of Yale College inquiring for a set of my fungi exsiccati. He wishes information also as to the microscopic fungi injurious to vegetation."

Various entries conveying information regarding the disposal of his fungus specimens appear in his diary.

" *October* 6, 1866. Received a letter yesterday from Mr. M. C. Cooke of the India Museum, London, inquiring about my Fungi Exsiccati. I have replied that I can furnish Vols. IV and V only of the set, and other loose specimens Cryptogams at $8 per 100 and Phaenogams at $10 per 100."

This was the beginning of what must have been a very profitable correspondence, but since no part of it has been discovered either in England or the United States, we can judge of its content only by the results. In the early stages of the correspondence between COOKE and RAVENEL, the Rev. E. C. BOLLES, then pastor of the Universalist Church of Portland, Maine, who was an ardent student of " Microscopy," served as an intermediary.

" *August* 22, 1867. Received today a letter from Rev. E. C. Bolles of Portland, Maine, inquiring for Mr. Cooke of London after my fungi. He orders all the numbers of my Exsiccati or as many as I can furnish and the loose specimens labelled of those that cannot be supplied. I will reply to Mr. Bolles today. I can send him Fasc. IV and V and about 200 species of the other sets.

October 7, 1867. I have written to Mr. M. C. Cooke of London to make two proposals.—1st to offer him my entire duplicate collection of fungi as they stand, he to pay me whatever he thinks they are worth on examination.—2ndly to offer them at ' about $3.00 per 100 specimens.' I'm going over, arranging the species and ascertaining the number of specimens—the specimens to be fair representatives of the species—to be sent to him through Rev. E. C. Bolles of Portland, Maine. I will send off today the package for Cooke which he has engaged, to Rev. Mr. Bolles with bill to be collected on delivery."

One result of this request from COOKE was that RAVENEL completely overhauled his fungus collection, no small task, as may be seen from the following entry in his diary.

" *April* 28, 1868. I have today finished overlooking my pile of fungi and have near 600 species, varying from one to 10 or 12 specimens—between 2500 and 3000 specimens now ready for sale or distribution.

I find a large number still unreported on by Berkeley and yet unnamed mostly Sphaeria and Polypores."

The entire duplicate collection of fungi, over thirty-six hundred specimens, was finally arranged in ten sets. The largest which contained over eight hundred specimens was purchased by COOKE who undertook the sale of two of the others. The second set was purchased by HORACE MANN who was to undertake the sale of the remaining six.

" *May* 8, 1866. Received a letter from Rev. E. C. Bolles enclosing one from Mr. Cooke of London in reply to mine of March 30th. He accepts my new proposition—viz. instead of taking my entire stock of duplicates, he will take one complete set at 16 shillings or $4.00 in gold."

The interval between the completion of the Fungi Caroliniani and the beginning of serious study and collecting for sale was only eight years but so much had happened in the meantime, and so easily does one become " rusty " in a field of science which is not regularly cultivated that RAVENEL writes seriously in June 1868, of " regaining " some of his " lost knowledge " among the fungi.

Sometime during 1868 RAVENEL loaned to Dr. JOHN SHAW BILLINGS of Washington eight volumes from his fungus collection, regarding which incident he made the following entry on the return of the specimens.

" *Sept.* 18, 1869. Received last night a box from Dr. Billings with my eight vols. (herb.) of Sphaeriacei which he has had for about two months under examination, taking drawings of the fructifications, and making a sketch of each on my labels. This has been an arduous task for him, but of great benefit to his aquisition of a more thorough knowledge of this order than he could have gained for a long time. His sketches of the fruit have added a value also to my collection. "

In 1869 and 1870 he devoted much time to the study and collection of lichens with the double purpose, as indicated in letters to TUCKERMAN, of securing sets of southern lichens suitable for sale and of helping TUCKERMAN in the preparation of his " Genera Lichenum."

RAVENEL's chief mycological work during the latter part of

his life was the publication of a second set of Exsiccati. This set entitled " Fungi Americani Exsiccati " was in eight centuries and was published in London from 1878 to 1882. It bears the names of H. W. RAVENEL and M. C. COOKE as joint authors. The specimens were determined by COOKE and were collected by RAVENEL principally in South Carolina, Georgia, and Texas. About thirty sets were prepared, the centuries being issued two at a time as follows : 1 and 2, 1878; 3 and 4, 1879; 5 and 6, 1881; 7 and 8, 1882.

After RAVENEL's death his collections of fungi and other cryptogams were sold to the British Museum. This insured their careful preservation and availability to the mycologists of the world. This valuable collection together with his two sets of exsiccati, and in less degree the sets of fungi he distributed during his life, constitute his principal botanical monument. For his publications, though they include several valuable papers, were relatively few. RAVENEL was distinctively a collector and field student of plants. Probably no more accurate and discerning appraisal of his work can be made even today than that written in the summer following RAVENEL's death by his contemporary and fellow mycologist, W. G. FARLOW.

" There was not a group of plants, no matter how small, which escaped his observation. It is doubtful whether any other American botanist has ever covered so wide a range of plants. He not only studied critically the phaenogams of South Carolina, but he collected and studied as far as it was possible at that time and in a region remote from large libraries, mosses, lichens, algae and fungi. But he was not an ordinary collector, heaping up rough material to be exchanged for specimens to be counted rather than studied. He was a most accurate observer, and always noted the habits and peculiarities of what he collected. He discovered a surprisingly large number of new species of cryptogams, besides a few new phaenogams. Probably no person had so complete a knowledge of the cryptogamic flora of the southern states as he... He was one of the pioneers of cryptogamic botany in this country. May those who follow be guided by the same spirit."

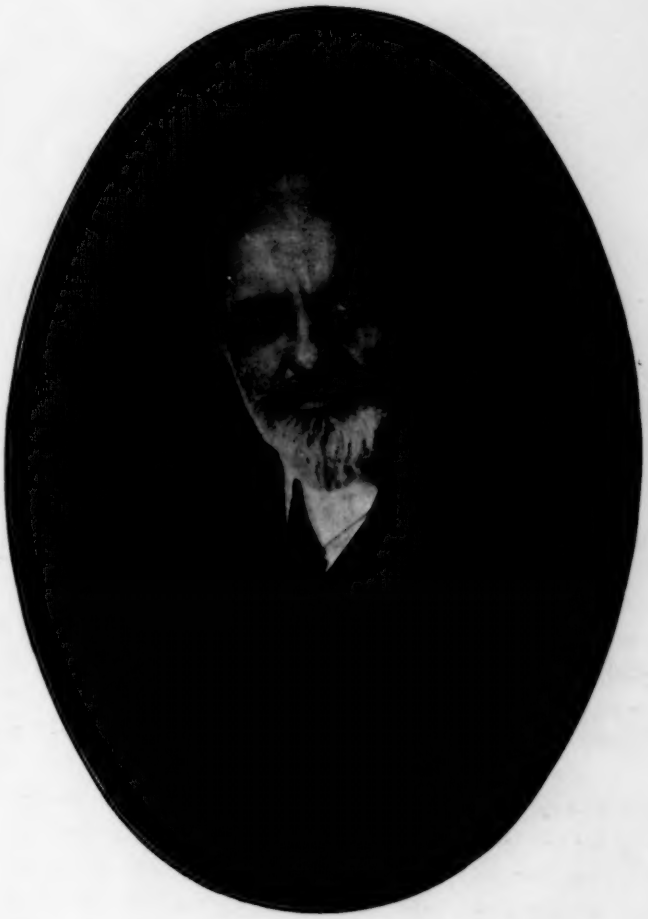
Bureau of Plant Industry NEIL E. STEVENS.
Washington, D. C.

Heinrich Wieleitner

(geb. 31.X.1874, gest. 27.XII.1931).

Noch ist uns der allzu frühe Tod von CARL SCHOY in frischer Erinnerung, und schon hat die Geschichte der Mathematik einen neuen schmerzlichen Verlust zu beklagen. HEINRICH WIELEITNER, Oberstudiendirektor und Honorarprofessor an der Universität München, ist am 27. Dezember v. J. im Alter von 57 Jahren einer heimtückischen Krankheit erlegen.

Niemand hätte dem in einfachen Verhältnissen aufwachsenden Knaben die Laufbahn voraussagen können, die den Mann bis zu den höchsten akademischen Ehren führte. Am 31. Oktober 1874 zu Wasserburg, einer vom Inn umflossenen alten Stadt Oberbayerns geboren, fand er auf der Schule die erste Förderung durch den Rektor KNÖRZER, der auf die Begabung des Schülers aufmerksam geworden war. Er erleichterte ihm den Besuch der Realschule, erteilte ihm Lateinunterricht und sorgte dafür, dass er in das bischöfliche Knabenseminar zu Scheyern aufgenommen wurde und später, durch Stipendien unterstützt, das Gymnasium zu Freising absolvieren konnte. WIELEITNER durchlief auch diese Schule mit Auszeichnung; die Erwartung freilich, dass er sich dem geistlichen Stande widmen würde, konnte er nicht erfüllen, und man war vernünftig genug, den Studenten seine eigenen Wege gehen zu lassen. Hatte er schon in Freising seine hervorragende Begabung für Mathematik bewiesen, so entwickelte sich an der Münchener Hochschule, hauptsächlich unter LINDEMANN, sein Können in raschestem Fortschreiten. Er wurde durch das grosse LAMONT'sche Stipendium ausgezeichnet, das ihm in Verbindung mit ausgedehntem Privatunterricht das Durchhalten ermöglichte, und erhielt nach glänzend bestandenem Staatsexamen 1897 eine mathematische Assistentenstelle an der Technischen Hochschule. Assistentenstellen sind aber keine



HEINRICH WIELEITNER

J. RUSKA

UNIV OF MICH

Dauereinrichtungen, und so folgte 1898 die Zuweisung an das Gymnasium in Speyer und 1900 die Anstellung an der gleichen Anstalt.

Im Frühjahr 1900 konnte WIELEITNER seine geliebte Käthe heimführen. In Speyer arbeitete er auch seine Promotionsschrift "Über die Flächen dritter Ordnung mit Ovalpunkten" aus. Im Anschluss daran reifte dann das erste grosse Werk, die "Theorie der ebenen algebraischen Kurven höherer Ordnung" (Teil I, Leipzig 1905, XXII + 313 S.; Teil II, Leipzig 1908, XVI + 409 S.), das ihn in diesen Jahren zu zahlreichen Spezialarbeiten auf dem gleichen Gebiet führte.

Der Frühling 1909 brachte mir die erste persönliche Begegnung mit WIELEITNER. Ich stand damals in Heidelberg mitten in den Schulkämpfen der Zeit und hatte die Aufgabe übernommen, das alte "Pädagogische Archiv", das in den Verlag von QUELLE und MEYER übergegangen war, im Sinne einer besonnenen Reform des höheren Schulwesens auszubauen. Das war natürlich nur möglich, wenn es gelang, einen Stab von gleichgesinnten Mitarbeitern aus allen Ländern und Gauen des Reichs zu gewinnen. Ein schulpolitischer Aufsatz in der Beilage zu den *Münchener N. Nachrichten* lenkte meine Aufmerksamkeit auf den bayerischen Mathematiker. Dass er sehr nahe wohnte, war mir besonders willkommen : die Türme von Speyer sieht man ja bei Heidelberg von jeder Anhöhe am Abendhimmel sich abzeichnen, in einer Stunde konnte man in Speyer sein. Meine Bitte, Referate für das Archiv zu übernehmen, fand freundliches Gehör; bald folgte dem Briefwechsel auch eine Einladung nach Speyer. Ich war überrascht, einen jungen Mann mit schmalem schwarzem Bart und dunklen Augen vor mir zu sehen, von fast südländischer Lebhaftigkeit, von energischer, bestimmter Sprache, aber auch voll fröhlichen bayrischen Humors. Der Kontakt mit dem jungen, lebensfrohen Paar war rasch gewonnen, wir konnten uns in den Dingen, die uns zusammengeführt hatten, leicht verständigen — der Tag legte den Grund zu einer Freundschaft, die über alle Schicksale und allen Wandel der Zeiten weg vorhielt, als ob wir Schulkameraden oder Studiengenossen gewesen wären. Schon damals lernte ich die Weite von WIELEITNERS geistigem Interessenkreis, vor allem seine Kenntnis der französischen Literatur bewundern. Wer ihn nur nach den mathematischen

Veröffentlichungen beurteilte, würde ein ganz unzulängliches Bild seiner Wesensart erhalten. Das reizende Bändchen "Schnee und Eis der Erde", das WIELEITNER 1913 veröffentlichte, und die Herausgabe des "Discours préliminaire de l'Encyclopédie par d'Alembert" können auch von Fernerstehenden als Zeugnisse seiner Vielseitigkeit gewertet werden.

Das Spätjahr 1909 brachte WIELEITNER die Versetzung an das Gymnasium zu Pirmasens, mir selbst die Loslösung von der Schule und den Übergang zur Universität. WIELEITNER setzte die literarische Tätigkeit auch in seinem neuen Wirkungskreise fort. Noch sind es in erster Linie Unterrichtsfragen, zu denen er das Wort ergreift. Aber der Tod von A. VON BRAUNMÜHL hatte ihn schon 1908 vor eine Aufgabe gestellt, die für ihn entscheidend wurde, da sie ihn endgültig zum Mathematikhistoriker erzog. Der Verlag GÖSCHEN hatte die Herausgabe einer Geschichte der Mathematik geplant, die in knapper Darstellung, aber unter Zugrundlegung des neuesten Standes der Forschung das vierbändige Werk von M. CANTOR ergänzen sollte. Die Arbeit war zwischen S. GÜNTHER und A. VON BRAUNMÜHL so verteilt, dass GÜNTHER die ältere Zeit bis zu DESCARTES, VON BRAUNMÜHL die neuere Entwicklung bis zum Ende des XVIII. Jahrhunderts behandeln sollte. GÜNTHER konnte seinen Band 1908 veröffentlichen, VON BRAUNMÜHL hatte nur Vorarbeiten hinterlassen. Hier sollte nun WIELEITNER eingreifen. Er wusste, welche Riesenaufgabe er auf sich nahm, und die Zusage fiel ihm schwer genug. In dreijähriger aufreibender Arbeit wurde der Stoff gesammelt und gesichtet, 1911 konnte der erste Teil des Werks, die Arithmetik, Algebra und Analysis umfassend, erscheinen; bis zur Veröffentlichung des zweiten Teils vergingen weitere zehn Jahre.

Ein Blick auf die Bibliographie zeigt, dass sich WIELEITNERS Arbeit in den sechs Jahren, die er in dem stillen Pirmasens zubrachte, auch auf zahlreiche Fragen der älteren Mathematik erstreckte. Der Aufschwung, den die mathematikgeschichtlichen Studien unter der unerbittlich strengen, aber gerade die Besten mitreissenden Führung von G. ENESTRÖM genommen hatten, musste überall zu gründlicher Prüfung und schärferer Fassung der CANTOR'schen Darstellung führen, ja zu ganz neuen Entdeckungen Anlass geben. So war WIELEITNER besonders bemüht, die Vorgeschichte der analytischen Geometrie und der mathema-

tischen Perspektive aufzuhellen, auch fesselte ihn die Spätscholastik nach der physikalischen Seite hin.

Im Jahre 1915 als Rektor der Realschule nach Speyer zurückberufen, erlebte WIELEITNER dort den Krieg, den Zusammenbruch Deutschlands und die Besetzung der Pfalz. Wir sahen uns wieder häufiger, besonders im Spätsommer 1915, als meine Freunde einen Teil der Ferien in der Nähe Heidelbergs zubrachten. Wir diskutierten die methodischen Fragen des mineralogischen und insbesondere des kristallographischen Unterrichts, da ich damals an meiner Methodik arbeitete. Studien zur Frühgeschichte der arabischen Algebra, die ich 1917 veröffentlicht hatte, brachten uns dann auf dem Gebiet der Mathematikgeschichte noch näher zusammen. Leider trat die räumliche Trennung bald wieder störend dazwischen, da WIELEITNER schon 1920 als Konrektor an das Realgymnasium nach Augsburg versetzt wurde. WIELEITNERS grundlegende Arbeit über die Erbteilungsaufgaben bei MUḤAMMAD ALCHWĀRAZMĪ, die er 1922 veröffentlichte, ist durch meine Voruntersuchungen veranlasst, und in den Jahren 1921-24 gab die durchgreifende Neugestaltung, der JOH. TROPFKE seine "Geschichte der Elementar-Mathematik" für die 2. Auflage unterzog, den Anlass zu einer für die beiden Überlebenden unvergesslichen Arbeitsgemeinschaft.

Wir sind in den an Erfolgen reichsten Abschnitt im Leben WIELEITNERS eingetreten, in das Jahrzehnt einer fieberhaften Tätigkeit und Produktion, die er sich neben seiner schweren beruflichen Belastung unter Anspannung der letzten Kräfte abgerungen hat. Eine neue Bearbeitung der "Geschichte der Mathematik", die nun das ganze Gebiet umspannte, erschien 1922-23, die Mitarbeit an verschiedenen neubegründeten Sammlungen zur Einführung in die Mathematik trug reiche Früchte. Nach GÜNTHERS Tod war WIELEITNER auch als Berichterstatter für Mathematik und exakte Naturwissenschaften in die Redaktion der *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften* eingetreten, wozu er bei seiner souveränen Beherrschung des Stoffs und seiner kritischen Veranlagung ganz besonders berufen war. In diesen Jahren beginnt auch seine Mitarbeit an den Zeitschriften *Isis* und *Archeion*.

WIELEITNER hatte die Fünfzig überschritten, als er — im Jahre 1926 — als Oberstudiendirektor an das Neue Realgymnasium

nach München berufen wurde. Für den Mann, der 25 Jahre in den vordersten Reihen der bayrischen Schulmänner gestanden hatte, eine wohlverdiente Ehrung, aber keine Entlastung; für den Mathematikhistoriker die Rückkehr an die Stätte, wo GÜNTHER und VON BRAUNMÜHL gewirkt hatten, und damit die Aussicht, sich selbst noch der akademischen Lehrtätigkeit widmen zu können. Bald trat der Ruf an ihn heran : er wurde ohne Vorlegung einer Habilitationsschrift zunächst als Privatdozent an die Universität gezogen und schon zwei Jahre später, am 17. Juli 1930, zum Honorarprofessor ernannt. Seine Probevorlesung behandelte das Fortleben der archimedischen Integrationsmethoden bis zum Beginn des XVII. Jahrhunderts; sie ist in erweiterter Form in den "Quellen und Studien zur Geschichte der Mathematik" veröffentlicht worden. Ich füge auch ein Verzeichnis der gehaltenen und angekündigten Vorlesungen bei, das ich der Freundlichkeit von Dr. J. E. HOFMANN verdanke :

S.S. 1928 : Erfindung und Entwicklung der analytischen Geometrie.
W.S. 1928-29 : Geschichte der Mathematik im Altertum I.
S.S. 1929 : Geschichte der Mathematik im Altertum II.
W.S. 1929-30 : Geschichte der Mathematik im Altertum III.
S.S 1930 : KEPLER als Mathematiker.
W.S. 1930-31 : Entwicklung der analytischen Geometrie nach DESCARTES. (Mit der Erkrankung 26.11.30 abgebrochen.)
S.S. 1931 : LEIBNIZens Erfindung der Differential- und Integralrechnung. (Wegen Erkrankung abgesetzt.)

Wer den Aufstieg und den äusseren Lebensgang HEINRICH WIELEITNERS überschaut, wird sagen müssen, dass ein reiches, volles, glückliches Leben einen tragischen Abschluss fand, bevor alle Früchte zur Reife kamen, die man von dem Fleiss und Scharfsinn des Entschlafenen erwarten durfte. Wer WIELEITNER als Schulmann gekannt hat, mit seiner Hingebung an den Beruf, seiner natürlichen, frischen, gradlinigen Art, die ihm das Vertrauen und die Achtung der engeren Fachgenossen ebenso eintrug wie die Anerkennung der vorgesetzten Behörden, der mag die literarische Lebensarbeit vielleicht in die zweite Linie rücken. Uns Historikern der Wissenschaft aber kommt es zu, an die Leistungen zu denken, die WIELEITNER für immer einen Ehrenplatz unter den Erforschern und Darstellern der Mathematikgeschichte

sichern; und mehr noch, das tragische Geschick zu beklagen, das diesen unermüdlichen Arbeiter dahingerafft hat, nachdem er kaum begonnen hatte, an der Stätte, die ihm gebührte, zu wirken und Schüler heranzuziehen.

Die Feder ist der Hand entsunken, der Mund ist geschlossen — die Werke aber, die WIELEITNERS Geist geschaffen, werden weiter leben und vorbildlich bleiben.

Berlin. JULIUS RUSKA.

BIBLIOGRAPHIE.

Das nachfolgende Schriftenverzeichnis umfasst alle Veröffentlichungen von H. WIELEITNER mit Ausschluss der Rezensionen und der mathematischen Aufgaben. Es ist von mir nach den von den Herren Dr. J. E. HOFMANN (Nördlingen) und Dr. K. VOGEL (München) freundlich zur Verfügung gestellten Verzeichnissen chronologisch geordnet und von Oberstudiendirektor Dr. J. TROPFKE ergänzt und durchgesehen worden, wofür ich allen Beteiligten auch an dieser Stelle herzlichsten Dank ausspreche.

Abkürzungen der Zeitschriftentitel:
AGM: Archiv für Geschichte der Medizin.
ANT: Archiv für Geschichte der Naturwissenschaften und der Technik.
AMNT: Archiv für Geschichte der Mathematik, der Naturw. und der Technik.
AMP: Archiv der Mathematik und Physik.
BBG: Blätter für das bayrische Gymnasial-Schulwesen.
BM: Bibliotheca Mathematica.
JBM: Jahresberichte der Mathematiker-Vereinigung.
MMN: Mitteilungen zur Geschichte d. Medizin u. d. Naturwiss.
NK: Natur und Kultur.
QSGM: Quellen und Studien zur Geschichte der Mathematik.
SBErl.: Sitzungsberichte der phys.-med. Sozietät zu Erlangen.
SBP: Sitzungsberichte der Preussischen Akademie der Wissenschaften.
SBW: Sitzungsberichte der Wiener Akademie.
UMN: Unterrichtsblätter für Mathematik und Naturwissenschaften.
ZMN: Zeitschrift für math. und naturw. Unterricht.

1901

Über die Flächen dritter Ordnung mit Ovalpunkten. Diss. München 1901. Gymnasial-Programm Speyer 1900/01. 45 S. 1 Tafel.

1903

Über die mathematisch-physikalische Lehraufgabe und die Ausbildung der Fachlehrer im Königreich Bayern. *Z M N* 34, 1903, S. 89-98.

Über die Aufgabe: "Ein beliebiges Tetraeder nach einem Parallelogramm zu schneiden." *U M N* 9, 1903, S. 49-50.

Aus dem Reiche der grossen Zahlen. *N K* 1, 1903/04, S. 133-139.

Gletscher. *N K* 1, 1903/04, S. 319-330.

„Lunulae Hippocratis". *B B G* 39, 1903, S. 541-543 und S. 642.

1904

Zwei Anwendungen der sog. Scheitelgleichung der Kegelschnitte. *Z M N* 35, 1904, S. 493-497.

Über die Schwerkraft. *N K* 2, 1904/05, S. 11-14.

1905

Bibliographie der höheren algebraischen Kurven für den Zeitabschnitt von 1890-1904. Leipzig 1905. Gymn.-Programm Speyer 1904/05. 58 S.

Theorie der ebenen algebraischen Kruven höheren Ordnung. *Sammlung Schubert* Nr. 43. Leipzig 1905. XXII und 313 S. 82 Fig.

1906

Loria, Gino. Vergangene und künftige Lehrpläne. Rede, gehalten zu Mailand den 22. April 1905. Autorisierte Übersetzung von H. Wieleitner. Leipzig 1906. 22 S.

Die Evoluten der Kegelschnitte. *Z M N* 37, 1906, S. 249-252.

Beitrag zur Lehre von den negativen Flächen. *U M N* 12, 1906, S. 33.

Der Zahl- und Mengenbegriff im Unterricht. *U M N* 12, 1906, S. 102-110.

Zur Entwicklung des Zahlbegriffes. *N K* 4, 1906/07, S. 97-104.

1907

Das Abrollen von Kurven bei geradliniger Bewegung eines Punktes. *A M P* 11_3, 1907, S. 307-314.

Die Parallelkurve der Klothoide. *A M P* 11_3, 1907, S. 373-375. 1 Fig.

Die Scheitelkonchoiden der Kegelschnitte. *A M P* 12_3, 1907, S. 254-260.

Note sur l'aire des podaires des coniques à centre. *Ann. Ac. Pol. Porto* 2, 1907, S. 1-4.

Über einige Zusammenhänge zwischen speziellen Quartiken. *S B W* 116, Abt. IIa, 1907, S. 1267-1278.

Über zwei Familien von rationalen Kubiken. *Monatshefte für Mathematik und Physik* 18, 1907, S. 132-137.

Über eine Verallgemeinerung des Begriffes der Mannheimschen Kurve. *Mitt. des Math.-Naturw. Vereins Württemberg* 9_2, 1907, S. 1-9.

1908

Spezielle ebene Kurven. *Sammlung Schubert* Nr. 56. Leipzig 1908. XVI und 409 S. 189 Fig.

Bericht über den iv. Internationalen Mathematikerkongress zu Rom vom 6.-11. April 1908. *Z M N* 39, 1908, S. 191-197 und 41, 1910, S. 372-385.

Zur Reform des mathematischen Unterrichtes an den Mittelschulen. Beilage der *Münchner Neuesten Nachr.* vom 3 Nov. 1908, S. 265-267.

1909

Die "Élements de Géometrie" des Paters J. G. Pardies. *A N T* 1, 1908/09, S. 436-442.

Mathematische Unterrichtsfragen auf dem iv. internationalen Mathematikerkongress. Gymn.-Programm Pirmasens 1909/10. 29 S.

1910

Pascals Repertorium der höheren Mathematik, 2., völlig umgearbeitete Auflage der deutschen Ausgabe. Unter Mitwirkung zahlreicher Mathematiker herausgegeben von E. Salkowski und H. E. Timerding. II. Band. Geometrie, herausgegeben von H. E. Timerding. 1. Teilband. Grundlagen und ebene Geometrie. Leipzig-Berlin 1910. Darin :

Projektive Spezialisierungen von Kurven vierter und dritter Ordnung (zusammen mit E. Ciani). S. 415-427.

Metrische Eigenschaften algebraischer Kurven. S. 428-452.

Besondere Erzeugungsarten ebener Kurven. Metrisch spezialisierte Kurven. S. 453-483.

Abhandlungen über den mathematischen Unterricht in Deutschland. *(I M U K)* II_1, Leipzig-Berlin 1910. Der mathematische Unterricht an den höheren Lehranstalten sowie Ausbildung und Fortbildung der Lehrkräfte im Königreich Bayern. Mit einem Ein führungswort von P. Treutlein. XVI und 85 S.

Über mehrfach perspektive Dreiecke. *A M P* 16_3, 1910, S. 206-212. Zugleich bei G. Faber-F. Hartoys, Gratulationsschrift zum 60. Geburtstag von Alfred Pringsheim, Leipzig 1910, S. 264-270.

Bayrische Schulfragen. *Pädag. Archiv* 52, 1910, S. 360-372.

Anton von Braunmühl. Mit Portrait und Schriftenverzeichnis. *B M* 11_3, 1910/11, S. 316-330.

1911

Geschichte der Mathematik. *Sammlung Schubert* Nr. 63. II. Teil :

Von Cartesius bis zur Wende des 18. Jahrhunderts. I. Hälfte : Arithmetik, Algebra, Analysis. Bearbeitet unter Benützung des Nachlasses von Dr. A. VON BRAUNMÜHL. Leipzig 1911. VIII und 251 S. 6 Fig.

Der Begriff der Zahl in seiner logischen und historischen Entwicklung. *Math.-phys. Bibl.* Nr. 2. Leipzig-Berlin 1911, 67 S. 10 Fig. 2. Aufl. 1918, 59 S. 3. Aufl. 1927, II und 59 S.

Discours préliminaire de l'Encyclopédie par D'ALEMBERT. *Französische Schriftsteller aus dem Gebiet der Philosophie* etc., herausg. von J. RUSKA, Band 5. Heidelberg 1911. 128 S.

Zur Methodik des Satzes von der Potenz am Kreise und der Ähnlichkeitslehre. *Z M N* 42, 1911, S. 421-423. 3 Fig.

Sur quelques généralisations de la "Courbe de Mannheim". *L'Enseignement mathématique* 13, 1911, S. 393-394.

Über das virtuelle Bild eines unter Wasser befindlichen Punktes. *U M N* 17, 1911, S. 132-133.

1912

Die sieben Rechnungsarten mit allgemeinen Zahlen. *Math.-phys. Bibl.* Nr. 7. Leipzig-Berlin 1912. 71 S. 2. Aufl. 1920, II und 71 S.

Marino Ghetaldi und die Anfänge der Koordinatengeometrie. *B M* 13_3, 1912/13, S. 242-247.

Ein Grenzfall des Ptolemäischen Lehrsatzes. *Z M N* 43, 1912, S. 172-175. 2 Fig.

Der "Tractatus de latitudinibus formarum" des Oresme. *B M* 13_3, 1912/13, S. 115-145. 12 Fig.

1913

Schnee und Eis der Erde. *Bücher der Naturwissenschaft* Bd. 16. Reclams Universalbibliothek Nr. 5521/23. Leipzig 1913. 198 S. 26 Abb., 16 Tafeln. 2. Aufl. 1920.

Über die "Plani-coniques" von de la Hire. *A N T* 5, 1913/15, S. 49-55.

Über zwei algebraische Einleitungen zu Descartes' Geometrie. *B B G* 49, 1913, S. 299-313.

Zwei Bemerkungen zu Stirlings "Lineae tertii ordinis Neutonianae". *B M* 14_3, 1913/14, S. 55-62.

Zur Geschichte der unendlichen Reihen im christlichen Mittelalter. *B M* 14_3, 1913/14. S. 150-168. 3 Fig.

Über den Funktionsbegriff und die graphische Darstellung bei Oresme. *B M* 14_3, 1913/14, S. 193-243. 8 Fig.

Die Behandlung der Perspektive durch Murdoch. *B M* 14_3, 1913/14, S. 320-335. 2. Fig.

"Kleine Mitteilungen" zu Cantor III², S. 534-535. *B M* 14_3, 1913/14, S. 348-349.

1914

Algebraische Kurven. Neue Bearbeitung. I. Teil. Gestaltliche Verhältnisse. *Sammlung Göschen* Nr. 435. Berlin und Leipzig 1914. 146 S. 97 Fig. 2. Aufl. 1919, 3. Aufl. 1930.

Zur graphischen Lösung von Gleichungen durch den Schnitt von Kurven. Mit einer Bibliographie der älteren Literatur. *U M N* 20, 1914, S. 34-35.

Das Gesetz vom freien Falle in der Scholastik, bei Descartes und Galilei *Z M N* 45, 1914, S. 209-228. 8 Fig.

Die Flugbahnen der Geschosse. *N K* 12, 1914/15, S. 342-348.

Kritische Bemerkungen zu den Vorschlägen des DAMNU zur Vereinheitlichung der mathematischen Bezeichnungen im Schulunterricht. *A M P* 23_3, 1914/15, S. 302-303.

1915

Zeichnung der Figuren in der Erd- und Himmelskunde. *Z M N* 46, 1915, S. 379-381 und S. 622.

Der Wortschatz der Mathematik, *Z M N* 46, 1915, S. 572-575.

Über die ursprüngliche Form des Pascalschen Lehrsatzes. *M M N* 14, 1915, S. 157-162. 3 Fig.

Meister Dietrich und seine Optik. *N K* 13, 1915/16, S. 1-5.

Das Brechungsgesetz bei Descartes und Snellius. *N K* 13, 1915/16, S. 403-406.

1916

Zur Erfindung der analytischen Geometrie. *Z M N* 47, 1916, S. 414-426. 2 Fig.

Zur Geschichte des Fallgesetzes. *Zeitschrift f. d. phys. und chem. Unterricht* 29, 1916, S. 157-158.

Nikolaus Oresme und die graphische Darstellung der Spätscholastik. *N K* 14, 1916/17, S. 529-536. 4 Fig.

Zur Geschichte der graphischen Darstellung von Funktionen. *J B M* 25, 1916/17, S. 66.

Über die Begriffe der Geschwindigkeit und Beschleunigung in der Scholastik. *Das Weltall* 17, 1916/17, S. 49-55.

1917

Das Stellenwertsystem und die Null bei den Maya. *Z M N* 48, 1917, S. 213-215.

Eine Näherungs-Konstruktion des Neunecks bei Dürer. *Z M N* 48, 1917, S. 328.

1918

Algebraische Kurven. Neue Bearbeitung. II. Teil. Allgemeine Eigenschaften. *Sammlung Göschen* Nr. 436. Berlin und Leipzig 1918. 123 S. 35 Fig. 2. Aufl. 1919.

Neue Untersuchungen zur ältesten arabischen Mathematik. *U M N* 24, 1918, S. 8-10.

Die Anfänge der analytischen Raumgeometrie. *Z M N* 49, 1918, S. 73-79. 4 Fig.

Das Stellenwertsystem bei den Maya und bei den Indern. *Z M N* 49, 1918, S. 147-148.

Der räumliche pythagoreische Lehrsatz. *Z M N* 49, 1918, S. 321-322.

Das x der Mathematiker. *M M N* 17, 1918, S. 82.

Benedetti als Perspektiviker. *M M N* 17, 1918, S. 190-195. 6 Fig.

1919

Neue Untersuchungen zur indischen Mathematik. Mit Bibliographie. *U M N* 25, 1919, S. 56-61.

Der mathematische Verein München. *Z M N* 50, 1919, S. 56-58.

1920

Bemerkung zu dem Aufsatz von E. Wiedemann über die Gärtnerkonstruktion der Ellipse. *Z M N* 51, 1920, S. 65.

Zur Erfindung der verschiedenen Distanzkonstruktionen in der malerischen Perspektive. *Repert. f. Kunstwiss.* 42, 1920, S. 249-262. 4 Abb.

Sur la préhistoire de la courbe de Hesse. *Ann. scient. Ac. Pol. do Porto* 14, 1920. S. 223-228.

Zur Erfindung des Zeichens x. *Z M N* 51, 1920, S. 145-148.

1921

Geschichte der Mathematik. *Sammlung Schubert* Nr. 64. II. Teil. Von Cartesius bis zur Wende des 18. Jahrhunderts. II. Hälfte. Geometrie und Trigonometrie. Berlin und Leipzig 1921. VI und 220 S. 13 Fig.

In W. Dieck, Mathematisches Lesebuch, Sterkrade 1921, Bd. IV der Abschnitt : "Zur Erfindung der analytischen Geometrie"; Bd. V der Abschnitt : "Zur Erfindung der Infinitesimalrechnung."

Bardey-Lengauer, Aufgabensammlung mit Einführung in den Lehrstoff

für die höheren Lehranstalten zunächst Bayerns. Neubearbeitung. Leipzig-Berlin. 8. Aufl. 1921. IV und 195 S. 13 Fig. 11. Aufl. 1929.

Mathematik und Kristallographie. *U M N* 27, 1921, S. 51-55.

Das erste Auftreten gebrochener Exponenten. *U M N* 27, 1921, S. 59-60.

Amerikanische Schulmathematik. *Z M N* 52, 1921, S. 77-78.

1922

Geschichte der Mathematik. Neue Bearbeitung. *Sammlung Göschen* Nr. 226 und 875. I. Von den ältesten Zeiten bis zur Wende des 17. Jahrhunderts. Berlin und Leipzig 1922. 136 S.

II. Von 1700 bis zur Mitte des 19. Jahrhunderts, Berlin und Leipzig 1923. 154 S.

Die Erbteilungsaufgaben bei Muhammed ibn Musa Alchwarazmi *Z M N* 53, 1922, S. 57-67.

Gebrochene Exponenten bei Michael Stifel. *U M N* 28, 1922, S. 63-64.

Notiz zu dem Aufsatz von W. Weinrich "Die Fadenzeichnung der Hyperbel usw." *J B M* 31, 1922, S. 175.

1923

Einführung in die ebenen und körperlichen Örter von Pierre de Fermat (um 1636). Aus dem Lateinischen übersetzt und mit Einleitung und Anmerkungen herausgegeben von H. WIELEITNER. *Ostwalds Klassiker* Nr. 208. Leipzig 1923. 22 S. 11 Fig.

G. VILEJTNER. Ponjatie o čisle. Perevod s 2. nem. izd. Evg. Rabinoviča Fiziko-matematičeskaja Biblioteka 1. Berlin 1923, 71 S. (Russische Übersetzung von : Der Begriff der Zahl).

Siegmund Günther †. *M M N* 22, 1923, S. 1-2.

Was lehrt die Geschichte der Mathematik über den Sinn dieser Wissenschaft? *A G M* 15, 1923, S. 27-32.

Geschichte der Wissenschaften im Unterricht. *U M N* 29, 1923, S. 50-54.

Eine amerikanische Geschichte der Zahlentheorie. *Z M N* 54, 1923, S. 110-111. (Bespr.)

1924

Die Geburt der modernen Mathematik. *Wissen und Wirken* Nr. 12. I. Die Analytische Geometrie. Karlsruhe 1924. 61 S. 12 Fig.

Zur Geschichte der gebrochenen Exponenten. *Isis* 6, 1924, S. 509-520 und *Isis* 7, 1925, S. 490-491.

Zur Geschichte der vierten Dimension. *Psych. Studien* 51, 1924, S. 618-619.

Gustaf Eneström †. *U M N* 30. 1924, S. 19.

Die Elementarmathematik und ihre Geschichte. *Das Weltall* 24, 1924/25, S. 128-134.

Die Geburt der modernen Mathematik. *Das Weltall* 24, 1924/25, S. 173-179. 6 Fig.

1925

Die Geburt der modernen Mathematik. *Wissen und Wirken* Nr. 13. II. Die Infinitesimalrechnung. Karlsruhe 1925. 72 S. 13 Fig.

Der Gegenstand der Mathematik im Lichte ihrer Entwicklung. *Math.-phys. Bibliothek* Bd. 50. Leipzig und Berlin 1925. 61 S. 20 Fig.

Über den Rauminhalt der Pyramide. *U M N* 31, 1925, S. 91-92. 1 Fig.

Zur ägyptischen Mathematik. *Z M N* 56, 1925, S. 129-137.

Zur muslimischen und ägyptischen Gleichungsauflösung. *Archeion* 6, 1925, S. 46-48.

Über die Wurzelrelationen der quadratischen Gleichungen, besonders bei Cardano. *Archeion* 6, 1925, S. 201-205.

Zur Frühgeschichte der Räume von mehr als drei Dimensionen. *Isis* 7, 1925, S. 486-489.

1926

Kannten die Ägypter den Begriff eines allgemeinen Bruches? *M M N* 25, 1926, S. 1-4.

Zu Bombellis Bezeichnung der Unbekannten und ihrer Potenzen. *Archeion* 7, 1926, S. 29-33.

Zusammenbruch der Wissenschaft? Zu einem neuen Buche von Hugo Dingler. *Südd. Monatshefte* 24, 1926/27, S. 61.

Über Cardanos Beweis für die Lösung der kubischen Gleichung. *S B Erl.* 58/59, 1926/27, S. 173-176.

Über die Fortschritte, die Simon Stevin in der Lösung der quadratischen Gleichung erzielte. *S B Erl.* 58/59, 1926/27, S. 177-180.

Mathematische Quellenstudien. *Das Weltall* 26, 1926/27, S. 186-191.

Isaac Newton. Zu seinem 200jährigen Todestage. *Südd. Monatshefte* 24, 1926/27, S. 39.

1927

Die trigonometrischen Lehren des persischen Astronomen Abu'l-Raiḥān Muḥammad Ibn Aḥmad al-Bīrūnī, dargestellt nach al-Qānūn al-Mas'ūdī von Karl Schoy. Nach dem Tode des Verfassers

herausgegeben von JULIUS RUSKA und HEINRICH WIELEITNER. Hannover 1927, XII und 108 S. 50 Fig.

Mathematische Quellenbücher. *Math.-naturw.-techn. Bücherei.* Bd. 3 I. Rechnen und Algebra. Berlin 1927. VIII und 75 S. 3 Fig. Bd. 11. II. Geometrie und Trigonometrie. Berlin 1927. VIII und 68 S. 22 Fig.

Über das x der Mathematiker. Bericht über die Verhandlungen der Deutschen Gesellschaft für Geschichte der Medizin und der Naturwissenschaften auf der Deutschen Naturforschertagung zu Düsseldorf vom 19.-24. September 1926. *Janus* 31, 1927, S. 4-5.

War die Wissenschaft der alten Ägypter wirklich nur praktisch? *Isis* 9, 1927, S. 11-28.

Isaac Newton. Zu seinem 200-jährigen Todestage. *U M N* 33, 1927, S. 103-107.

Mathematische Quellenstudien im Unterricht. *U M N* 33, 1927, S. 312-315.

Zur Frühgeschichte des Imaginären. *J B M* 36, 1927, S. 74-88.

Karl Schoy †. *J B M* 36, 1927, S. 163-167.

Bemerkung zu vorstehendem Aufsatz (d.h. zu BORTOLOTTI, Sulla rappresentazione simbolica etc. da Bombelli) *Archeion* 8, 1927, S. 64.

Die Grundlagen der ägyptischen Bruchrechnung. Zu einem Buch dieses Titels. *A M N T* 10, 1927/28, S. 233-237.

Die Elemente des Euklid. Zur neuen Auflage der Ausgabe von HEATH. *A M N T* 10, 1927/28, S. 238-240. (Bespr.)

Das Experiment. *Südd. Monatshefte* 25, 1927/28, S. 615-617. (Bespr.)

1928

ZWERGER-KLUG, Leitfaden der Elementarmathematik mit Aufgabensammlung. 15. Aufl. 3. Teil. Trigonometrie, neu bearbeitet von H. WIELEITNER. München, 1928, IV und 60 S. 42 Fig.

Mathematische Quellenbücher. *Math.-naturw.-techn. Bücherei* Bd. 19. III. Analytische und synthetische Geometrie. Berlin 1928. VIII und 89 S. 22 Abb.

Historia de la Matemática. Traducción de Carlos Mendizábal Brunet. *Coll. Labor*, Sección XI, No. 138-139. Barcelona 1928. 348 S.
Nicht autorisierte Übersetzung der "Geschichte der Mathematik", Sammlung Göschen.

Von der arithmetischen Scherzaufgabe zur mathematischen Formel. Aus: P. SIEBERTZ, Wunder im Weltall, 1928, S. 240-253.

Zur Entstehung der analytischen Raumgeometrie. *Z M N* 59, 1928, S. 357-58.

Zur Geschichte der Polargleichung der Ellipse. *U M N* 34, 1928, S. 276-77.

Materie und Schwerkraft in Newtons theoretischer Physik. Zu einem Buche dieses Titels. *A M N T* 11, 1928/29, S. 213-215. (Bespr.)

1929

Mathematische Quellenbücher. *Math.-naturw.-techn. Bücherei.* Bd. IV. Infinitesimalrechnung. Berlin 1929. VIII und 160 S. 29 Fig.

Bemerkungen zu Fermats Methode der Aufsuchung von Extremwerten und der Bestimmung von Kurventangenten. *J B M* 38, 1929, S. 24-35.

Christian Huygens zu seinem 300. Geburtstage. *U M N* 35, 1929, S. 109-117.

Zum dreihundertjährigen Geburtstag von Christian Huygens. Vortrag auf der 22. Tagung der Gesellschaft für Geschichte der Medizin und der Naturwissenschaften vom 5.-9. September 1929 zu Pest. *Münch. med. Wochenschrift* 42, 1929, S. 1777. (Notiz.)

Die Verdienste von John Wallis um die analytische Geometrie. *Das Weltall* 29, 1929/30, S. 56-60. 2 Fig.

Über das x der Mathematiker. *A M N T* 12, 1929/30, S. 93-100.

Eine neue mathematisch-historische Zeitschrift : Quellen und Studien zur Geschichte der Mathematik, herausg. von O. Neugebauer, J. Stenzel, O. Toeplitz. *A M N T* 12, 1929/30, S. 105-107.

Zur Geschichte der mathematischen Bezeichnungen. Besprechung eines Werkes von Fl. Cajori. *A M N T* 12, 1929/30, S. 221-223.

1930

Über Keplers "Neue Stereometrie der Fässer". *Kepler-Festschrift* Regensburg 1930. Berichte des naturwissenschaftlichen Vereins zu Regensburg für 1928/30, S. 279-313. 19 Fig.

Die Entwicklung des mathematischen und naturwissenschaftlichen Unterrichts in Bayern. Festschrift zur 32. Hauptversammlung des Vereins zur Förderung des mathematischen und naturwissenschaftlichen Unterrichts in Würzburg. Würzburg 1930, S. 53-64.

Zur Geschichte der sog. Rytzschen Achsenkonstruktion einer Ellipse aus einem Paar konjugierter Durchmesser (Zus. mit Jos. E. Hofmann), *Nieuw Archief voor Wiskunde*. II. Reihe, Teil XVI, 1930. S. 5-22.

Das Fortleben der Archimedischen Infinitesimalmethoden bis zum Beginn des 17. Jahrhunderts, insbesondere über Schwerpunktbestimmungen. *Q S G M* Abt. B, 1, 1930, S. 201-220.

Zur Geschichte der Entdeckung des babylonischen Sexagesimalsystems. Historische Studien und Skizzen zur Natur- und Geisteswissenschaft. Festgabe für GEORG STICKER. Berlin 1930. S. 11-17.

Neues zur babylonischen Mathematik. *Forschungen und Fortschritte* 6, 1930, S. 319-320.

Keplers "Archimedische Stereometrie". *U M N* 36, 1930. S. 176-185. 10 Fig.

Erste Versuche Leibnizens und Tschirnhausens, eine algebraische Funktion zu integrieren (Zus. mit JOS. E. HOFMANN), *A M N T* 13, 1930/31, S. 277-292. 3 Abb.

Zur neuen Auflage von Tropfkes „Geschichte der Elementarmathematik". *A M N T* 13, 1930/31, S. 463-466.

Babylonische Mathematik. *N K* 28, 1930/31, S. 113.

1931

Der Abstand eines Punktes von einer Geraden bei Schooten und Leibniz. *Z M N* 62, 1931, S. 18-20. 1 Fig.

Die Differenzenrechnung bei Leibniz (Zus. mit JOS. E. HOFMANN und mit Zusätzen von D. MAHNKE) *S B P.*, Phys.-math. Klasse 26, 1931, S. 562-600.

Additions et Corrections à Suter

"Die Mathematiker und Astronomen der Araber"

AVANT-PROPOS

Le regretté TANNERY a dit tout le bien qu'il pensait de l'ouvrage de H. SUTER, paru à Leipzig en 1900, premier essai d'un répertoire bio-bibliographique accessible aux non-arabisants sur l'histoire des sciences exactes chez les peuples musulmans (1). Les sources utilisées sont indiquées en tête de ce livre. Alors que ses devanciers ne disposaient guère que des renseignements contenus dans le *Fihrist*, les dictionnaires biographiques d'IBN AL-QIFṬÎ, IBN KHĀLLIKAN, IBN ABÎ UṢAIBI'A, ḤÂJJÎ KHALÎFA, le *Nafḥ aṭ-ṭîb* d'AL-MAQQARÎ, et quelques autres, SUTER a eu l'heureuse fortune de pouvoir y ajouter la remarquable collection de textes publiés peu auparavant par CODERA sur les savants de l'Espagne musulmane (2). Il y a trouvé des documents dont on n'avait eu jusqu'alors connaissance que d'une façon fragmentaire et imparfaite par la trop célèbre *Bibliotheca arabico-hispana escurialensis* de CASIRI, qui fut malheureusement, un siècle durant, comme le « pain quotidien » des historiens de la littérature arabe.

Un orientaliste de la valeur de HARTWIG DERENBOURG a pu tenter de défendre la mémoire du religieux maronite, en montrant qu'il dut, pour plaire à ses contemporains, « fusionner et concilier la science orientale indigène avec les goûts et tendances de la chrétienté espagnole du XVIII^e siècle » (3). Les parties proprement

(1) *Revue de synthèse historique*, t. VI (1903), p. 301, sq.

(2) *Bibliotheca arabico-hispana*, 8 vol., Madrid, 1883-92.

(3) *Les manuscrits arabes de l'Escurial*, t. I, Paris, LEROUX, 1884, Avant-propos, p. XXVII.

littéraires et historiques de l'œuvre de CASIRI sont peut-être acceptables. On ne saurait en dire autant des deux grandes sections qui ont trait à la médecine et aux sciences exactes.

LUCIEN LECLERC s'en était déjà plaint tout au long de son *Histoire de la médecine arabe* (4), après avoir fait le voyage de l'Escurial et constaté par lui-même les méprises et les omissions de CASIRI. SUTER, malgré la prudence justifiée qu'il montre vis-à-vis des assertions de cet écrivain, n'a pas pu toujours les contrôler, et les reproduit souvent dans son ouvrage. Même après lui, Mr J. A. SÁNCHEZ PÉREZ, cependant sur place, a eu le grand tort de se fier à la *Bibliotheca* de CASIRI pour la rédaction de son répertoire : *Biografias de matemáticos árabes que florecieron en España* (*Isis*, 4, 537) (5).

Les principales rectifications que j'apporte au livre de SUTER concernent donc les manuscrits scientifiques du fonds arabe de l'Escurial. Je les ai relevées moi-même à la suite de la mission qui me fut confiée de poursuivre la rédaction du catalogue français laissé inachevé par H. DERENBOURG. On sait aujourd'hui qu'une bonne partie de ce fonds provient de la bibliothèque privée du sultan sa'dien MOULAY ZÎDÂN, prise sur mer en 1612 par les Espagnols, alors en guerre avec le Maroc, et jamais rendue, malgré les efforts des diplomates (6). Il est donc naturel que je joigne à ces corrections des additions provenant des manuscrits, marocains pour la très grande majorité, rassemblés à Rabat, à la Bibliothèque générale du Protectorat français, depuis sa fondation jusqu'en 1920. L'inventaire de ces 543 premiers numéros, dont beaucoup de recueils factices, a été publié l'année suivante par Mr E. LÉVI-PROVENÇAL (7).

J'ai donné aux auteurs non biographiés par SUTER des numéros venant à la suite des siens, quelle que fut l'époque de ces écrivains, plutôt que de les intercaler, mais il m'a fallu citer de nouvelles sources. Suivant le plan adopté par lui, je les indique en tête de

(4) Paris, LEROUX, 1876, 2 vol., in-8°.

(5) Madrid, 1921. Il en est de même de son récent ouvrage : *Las matematicas en la Biblioteca del Escorial* (*Isis*, 13, 128-29), où se perpétuent plusieurs erreurs de CASIRI.

(6) Cf. H. DE CASTRIES, *Sources inédites de l'histoire du Maroc. Dynastie saâdienne*, Paris, LEROUX, in-4°, en cours de publication.

(7) Publications de l'Institut des Hautes Études marocaines, t. VIII, Paris, LEROUX, 1921, in-8°.

ma liste. Beaucoup, malheureusement, sont des ouvrages devenus rares, et peu abordables aux non-arabisants, collections biographiques rédigées par des savants maghribins à partir du XVI^e siècle et lithographiées à Fès au cours des soixante dernières années (8). Un très petit nombre de ces recueils a eu les honneurs d'une traduction, besogne évidemment ingrate, en raison des longueurs qu'ils contiennent, du moins à notre point de vue. Il est pourtant désirable qu'on en donne au moins des rééditions avec des notes et des index, ceux qui existent étant vraiment trop difficiles à consulter.

Par contre, je n'ai pu suivre en tous points le mode de transcription de l'arabe employé par SUTER. Il s'était écarté d'ailleurs du système adopté en Allemagne, déjà à son époque, notamment par C. BROCKELMANN, dans son indispensable manuel de littérature arabe (9), et qui prévaut aujourd'hui en France. Il a, comme on sait, l'avantage de rendre chaque lettre arabe par une seule lettre latine, avec, au besoin, l'aide d'un point ou signe distinctif placé au dessus ou au dessous. L'apprentissage en est très rapide. J'avoue ne revenir qu'avec regret au procédé des lettres doubles : *th*, *kh*, *dh*, *sh* et *gh*, pour remplacer les caractères diacrités qui manquent chez l'imprimeur d'*Isis*.

Quant aux abréviations, je me borne à un petit nombre, et des plus courantes : *ms.* pour manuscrit (*mss.* au pluriel), *cat.* pour catalogue, *trad.* pour traduction, *p.* page, *l.* ligne, *t.* tome. *chap.* chapitre, etc., et, en arabe, *K.* pour *Kitāb* (livre), *b.* pour *ibn* ou *ben* (fils) dans les noms propres.

Il convient, en terminant, que j'indique, pour quelques manuscrits de l'Escurial, la plupart recueils factices de mathématiques et d'astronomie, la correspondance entre la numérotation de la *Bibliotheca* de CASIRI et celle de l'inventaire manuscrit actuel, adoptée par DERENBOURG, et que j'ai, moi aussi, respectée. En général, il y a cinq numéros de différence entre CASIRI et l'inventaire : CMII du premier correspond à 907 du second, mais il y a des exceptions, surtout vers la fin de la section des *Mathematici*. Ainsi, on a :

(8) La liste en a été donnée par MM. BEN CHENEB et LÉVI-PROVENÇAL ; cf., *infra*, Bibliographie : *Répert.*

(9) Cf. Bibliographie : *G. A. L.*

Casiri	Inventaire	Casiri	Inventaire
CMVI-CMVII	en déficit	CMLXIV	en déficit
CMXLIII	954	CMLXV	968
CMXLVIII	948	CMLXVI	969
CMXLIX	953	CMLXXI	977
CMLXIII	970	CMLXXII	976

BIBLIOGRAPHIE

Bustān. — *al-Bustān fī dhikr al-awliyā' bi Tilimsān*, sur les personnages illustres de Tlemçen, par Muḥammad Ibn Maryam, ed. Ben Cheneb, Alger 1326/1908 J.-C., in-8°.

Chorfa. — *Les historiens des Chorfa. Essai sur la littérature historique et biographique au Maroc du XVI^e au XX^e siècle*, par E. Lévi-Provençal, Paris, Leroux, 1922, in-8°.

Enc. Isl. — *Encyclopédie de l'Islam*, éd. française, en cours de publication, Leyde et Paris, in-4°, t. I (A à D); t. II (E à K).

G. A. L. — *Geschichte d. arabisch. Literatur*, par C. Brockelmann, t. II, Berlin, 1902, in-8°.

Idjâza. — *Étude sur les personnages mentionnés dans l'idjâza du cheikh 'Abd el-Qâdir el-Fâsy*, par Mohammed Ben Cheneb, Paris, 1907, in-8° (Extr. des Actes du XIV^e Congrès des Orientalistes, Alger, 1905).

Jadwa. — *Jadwat al-iqtibās*, sur les notabilités de la ville de Fès, par Ibn al-Qāḍī (1553-1616 J.-C.), lith. Fès 1317/1899 J.-C., in-8°.

Nashr. — *Nashr al-mathānī*, sur les personnages illustres des XI^e et XII^e siècles de l'Hégire, par Muḥammad al-Qādirī (1712-1773 J.-C.), lith. Fès, 1315 Heg., 2 vol., in-8° et trad. française par A. Graulle, P. Maillard et E. Michaux-Bellaire, *Archives Marocaines*, t. XXI et XXIV, Paris, 1913 et 1917.

Nail. — *Nail al-ibtihāj*, complément au *Dībāj* d'Ibn Farḥūn, par Aḥmad Bābā al-Sudānī (1556-1627 J.-C.), lith. Fès, 1317 Hég., in-8°.

Répert. — *Essai de répertoire chronologique des éditions de Fès*, par M. Ben Cheneb et E. Lévi-Provençal (Extrait de la *Revue africaine*, Alger, 1922).

Sa'āda. — *al-Sa'ādat al-abadīya*, sur les personnages célèbres enterrés à Marrakech, par IBN AL-MUWAQQIT, lith. Fès, 1336 Hég., 2 vol., in-8°.

Ṣafwa. — *Ṣafwa man intashar...*, sur les personnages célèbres du XI[e] siècle de l'Hégire, par AL-IFRĀNĪ (1669-1738 J.-C.), lith. Fès, 1319 Hég., in-8°.

Salwa. — *Salwat al-anfās*, sur les personnages célèbres enterrés à Fès, par MUḤAMMAD B. JA'FAR AL-KATTĀNĪ, lith. Fès, 1316 Hég., 3 vol., in-8°.

ADDITIONS ET CORRECTIONS

— 13. ['UMAR B. AL-FARRUKHĀN AL-ṬABARĪ], p. 8, l. 6. Extraits des *masā'il* (questions) : Escurial n[os] 938_3 et $_{10}$ actuels. D'autre part, le ms. 917 de CASIRI (actuel 922_1) est bien le même que les mss. de Berlin n° 5878, Paris n° 2600_1, etc.; il est divisé en 140 chap. (et non 150 comme ap. CASIRI).

— 23. ['ALĪ B. 'ISĀ AL-USṬURLĀBĪ[, p. 13, l. 22. Le ms. 972_3 de CASIRI (actuel 976_3) renferme bien la *risāla fī 'ilm al-usṭurlāb* de cet astronome que CASIRI appelle à tort al-Ishbīlī (de Séville).

— 26. [SAHL B. BISHR], p. 15, l. 29. Le ms. 914_1 de CASIRI (actuel 919_1) est identique au ms. du Caire, cat. t. V, p. 268, intitulé : *fi l-aḥkām fī 'ilm al-mīqāt*.

— 53. [ABŪ MA'SHAR], p. 29, l. 5. Le ms. de l'Escurial n° 912 de CASIRI (actuel 917) porte aussi le titre de *K. aḥkām taḥwīl sini l-mawālīd*, comme le n° 2588 de Paris, et il en existe un second exemplaire, mais incomplet, à l'Escurial, n° 977 actuel. — *Ibid.*, l. 14. Le *K. as-sirr* (livre du secret) existant à l'Escurial, n° 933_1 de CASIRI (actuel 938_1), est différent de l'opuscule intitulé : *al-asrār al-nujūmīya* (les secrets astraux) du même auteur, également à l'Escurial, n° 913_6 de CASIRI (actuel 918_6.) Ce dernier est le même ouvrage que le ms. du Caire, cat. t. V, p. 369, intitulé *asrār al-nujūm* (les secrets des astres).

— 62. [IBN AL-KHAṢĪB AL-KŪFĪ], p. 32, dernière ligne, et 33, l. 4. Les mss. 935 et 973 de CASIRI (940 et 978 actuels) contiennent tous deux le *K. al-muqni' fi l-mawālīd*, mais le premier

est incomplet ou abrégé. Rien n'autorisait CASIRI à y voir l'œuvre d'IBN 'AZRA, l'astronome juif de Tolède (XII^e s. J.-C.).

— 66. [THĀBIT B. QURRA], p. 37, l. 8. Rien ne prouve non plus, en dépit de l'affirmation de CASIRI, que le court fragment où il est question du triangle rectangle, au ms. 955_8 de l'Escurial (actuel 960_5), soit du célèbre mathématicien de Ḥarrân, auteur de l'opuscule qui précède dans le même recueil.

— 88. [AL-FAḌL AL-NAIRĪZĪ], p. 45, l. 32. Au ms. de l'Escurial n° 956_6 de CASIRI (actuel 961_6), il ne s'agit pas de globe céleste, mais d'astrolabe sphérique. Sur cet instrument, cf. *Enc. Isl.*, I, 500, s. *Asṭurlāb*, par C. A. NALLINO.

— 170. [SA'ĪD B. FATḤŪN], p. 73, l. 25. L'hypothèse, hasardée par SUTER, de l'identité entre ce personnage et celui qui est nommé au ms. de l'Escurial n° 945 de CASIRI (actuel 950) : SHA'YĀ (ISAÏE) B. FIRĪGHŪN (sic), auteur d'une encyclopédie scientifique datée de 393/1003 J.-C., ne me paraît pas justifiée. Ce dernier est dit « élève d'ABŪ ZAYD AḤMAD B. ZAYD AL-BALKHĪ ». Je me demande s'il ne faut pas lire « B. SAHL AL-BALKHĪ ». Il s'agirait alors du philosophe et géographe persan † 322/934 J.-C. (cf. *G. A. L.*, I, 229; *Enc. Isl.*, I, 638), d'autant plus que le nom de l'émir ABŪ 'ALĪ AḤMAD B. MUḤAMMAD B. AL-MUẒAFFAR (dont CASIRI fait, naturellement, un prince de Cordoue) à qui l'ouvrage est dédié, correspond parfaitement à celui d'un prince persan de la dynastie des Muḥtājides (cf. ZAMBAUR, *Manuel de généalogie*, p. 204).

— 176. [MASLAMĀ B. AḤMAD AL-MAJRĪṬĪ], p. 76, l. 30. L'opuscule qui figure au n° 967_3 de CASIRI (actuel 972_3) n'a pas trait à la description et à l'usage de l'astrolabe, mais à des questions de trigonométrie sphérique, comme l'opuscule de THĀBIT B. QURRA qui le précède dans le même recueil (SUTER, p. 37, l. 9).

— 194. [IBN AL-SAMḤ], p. 85, l. 27. Le *K. al-kāfī fi l-ḥisāb* est aussi à l'Escurial, n° 973_1 actuel.

— 196. [IBN AL-ṢAFFĀR], p. 86, l. 6. Le *K. al-'amal bi l-usturlāb* est aussi à l'Escurial, n° 964_1 actuel, et à Rabat, n^os^ 455_4 et 502_3 (fragment).

— 204. [IBN AL-HAITHAM], p. 95, l. 11. La *qasīda* en *'ain* sur le zodiaque est aussi à l'Escurial, n° 976_2 actuel.

— 218. [AL-BĪRŪNĪ], p. 99, l. 32. Un exemplaire du *K. al-tafhīm li-awā'il sinā'at al-tanjīm* est à Rabat, n° 439.

— 219. [IBN ABI L-RIJĀL], p. 100, l. 11. J. A. SÁNCHEZ PÉREZ, *op. cit.*, p. 58, a déjà relevé l'erreur de CASIRI, qui fait de cet auteur d'ouvrages astrologiques un Espagnol. — *Ibid.*, l. 24. Un exemplaire incomplet du *K. al-bāri' fī aḥkām al-nujūm* est à Rabat, n° 465.

— 320. [IBN AL-YĀSMĪN], p. 130, l. 14. L'*urjūza* sur l'algèbre n'est pas au n° 943_6 de CASIRI (actuel 954_6), mais au n° 943_2 (actuel 954_2); c'est celle dont CASIRI dit : *Anonymi poema de algebra*; tandis que le n° 943_6 dont CASIRI dit : *Ibn Yasmin poema de arithmeticæ regulis*, est une autre *urjūza* de cet auteur marocain, intitulée *fi l-judhūr* (sur les racines), de 54 vers.

— 325. [AL-BIṬRŪJĪ], p. 131, l. 16. C'est CASIRI qui appelle cet astronome NŪR AL-DĪN AL-ISHBĪLĪ. Au ms. n° 958 de l'Escurial (actuel 963), je n'ai vu qu'AL-BIṬRŪJĪ.

— 368. [NAṢĪR AL-DĪN AL-ṬŪSĪ], p. 152, l. 27. Le commentaire sur le *K. al-thamara (Centiloquium)* de PTOLÉMÉE est aussi à l'Escurial, n° 922_2 actuel.

— 371. ['ALĪ B. ABĪ 'ALĪ AL-QUSṬANṬĪNĪ (sic)]. AL-GHARNĀṬĪ (de Grenade) est encore une addition de CASIRI. Cet auteur d'un poème astronomique existant à l'Escurial n° 904_2 (actuel 909_2) n'a pu vivre vers 653/1255 J.-C., car l'œuvre est dédiée au sultan mérinide [ABŪ SĀLIM] IBRĀHĪM AL-MUSTA'ĪN (1359-61 J.-C.).

— 376. [YAḤIĀ B. ABI L-SHUKR], p. 156, 2e alinéa. Le ms. de l'Escurial n° 927 de CASIRI (actuel 932) est bien de cet auteur.

— 381 *b*. [ABU 'ALĪ AL-ḤUSAIN B. AḤMAD B. MĀṢ (?) AL-ISLAMĪ]. Le ms. de l'Escurial n° 956_7 de CASIRI (actuel 961_7) a 160 chap., et non 161. Le même ouvrage est à Rabat n° 451_1, mais mis (je crois à tort) sous le nom du père de l'auteur, et avec une variante dans le nom : AḤMAD B. YŪSUF B. BĀṢ, *amīn al-awqāt* (syndic du corps des calculateurs de l'heure) à Cordoue. Il traite de l'emploi de la tablette universelle de l'astrolabe plan *al-ṣafīḥat al-jāmi'a li-jamī'al-'urūḍ*. Un court abrégé sans divisions est à Londres n° 408_9; l'auteur est appelé ABU L-ḤASAN B. ABĪ JA'FAR AḤMAD B. YŪSUF B. NĀṢIR AL-ISLĪMĪ (sic) de Grenade. Je crois que B. NĀṢIR est une

mauvaise lecture du copiste pour B. Bāṣ (nom qui indique une origine israélite; AL-ISLAMĪ= le converti à l'Islām). Cf. aussi *infra*, 543.

— 388. [MUḤAMMAD B. IBRĀHĪM IBN AL-RAQQĀM] AL-AWSĪ, de Murcie, me paraît être le même que l'auteur (cité *infra* n° 417, sous le nom d'ABŪ 'ABD ALLĀH AL-ḤĀSIB) de la *risāla fī'ilm az-zilāl*, qui est à l'Escurial, n° 913_7 (actuel 918_{11}). La date du 6 *rabī'I* 762 donnée par CASIRI est fausse (SUTER, dans ses remarques, p. 221, n° 85, l'a d'ailleurs pressenti). L'auteur, qui vécut à Grenade, y est mort le 21 *ṣafar* 715 (27 mai 1315 J.-C.), d'après IBN AL-KHAṬĪB, *Iḥāṭa*, ms. n° 1673 actuel de l'Escurial, p. 107. J. A. SÁNCHEZ PÉREZ, *op. cit.*, p. 109, a déjà fait cette rectification, mais il adopte la leçon (à mon avis fautive) Benelzacam.

— 399. [IBN AL-BANNĀ'], p. 162, l. 23. Le *Talkhīs* est bien au n° 948_1 de l'Escurial; il y en a d'autres exemplaires : n^{os} 248_{11}, 748_{18} et 954_1 (actuels) de la même bibliothèque, et un à Rabat n° 526_2.

— 403. [AL-JAGHMĪNĪ], p. 164, dernière ligne. Le *Mulakhkhaṣ* est aussi à Rabat n° 451_5.

— 406. [AL-MIZZĪ], p. 165, l. 26. Le ms. de l'Escurial n° 956_5 de CASIRI (actuel 961_5) n'est pas l'ouvrage intitulé *al-rawḍat al-muzhira*, mais un abrégé de la *risāla fi l-mujannaḥa* (instrument à ailes) existant à Paris, n° 2547_{23}. Enfin, il y a à Rabat, n° 452_5, sous le nom d'AL-MIZZĪ, une *urjūza* intitulée : *al-lu'lu' al-muhaddab fī 'amal bi l-rub'al-mujayyab*, sur l'usage du quart de cercle à sinus, en 20 chap. et une introduction.

— 415. ['ABD AL-'AZĪZ AL-HAWĀRĪ]. Le commentaire du *Talkhīṣ* d'IBN AL-BANNĀ' (*supra* 399), qui est à l'Escurial n^{os} 948_2 et 949 de CASIRI (le dernier est l'actuel 953_1) est intitulé *Ghāyat al-kuttāb*, ou encore *al-Lubāb*. Il est dédié non pas au vizir d'un prince de Grenade, mais à 'ABD ALLĀH B. ABĪ MADYAN, ministre du sultan mérinide ABŪ YA'QŪB YŪSUF B. YA'QŪB B. 'ABD AL-ḤAQQ (1286-1307 J.-C.). Le nom de « ben Omad » résulte d'un contre-sens de CASIRI.

— 417. Cf. *supra* n° 388.

— 421. [JAMĀL AL-DĪN AL-MĀRIDĪNĪ], p. 170, l. 21. Le ms. de l'Escurial n° 926_2 de CASIRI (actuel 931_2) ne contient pas d'ouvrage de cet auteur sur le quart de cercle à sinus, en

20 chap., mais *al-Maṭlab* de SIBṬ AL-MĀRIDĪNĪ (*infra* 445). La *risāla* de JAMĀL AL-DĪN sur ce sujet est au n° 970_7 actuel de l'Escurial, identique au n° 5823 de Berlin. Je crois, d'après un passage du ms. n° 451_4 de Rabat (commentaire), qu'elle est intitulée *Mujmalat al-maṭlub fi l-'amal bi rub'al-juyūb*. Enfin, au n° 970_9 actuel de l'Escurial, existe la *Ghāyat al-intifā'*, sur l'usage du même instrument muni d'un orifice à l'extrémité de l'arc de la hauteur, en 10 chap. Un exemplaire du *Durr al-manthūr* est à Rabat, n° 451_3, avec le titre d'*al-sittīnīya* (à cause de ses 60 chap.).

— 422. [IBN AL-QUNFŪDH], p. 170, avant-dernière ligne. Le commentaire sur l'*urjūza* astrologique d'IBN ABI L-RIJĀL (*supra* 219) est aussi à Rabat n^{os} 466, 467 et 512 bis. Cette bibliothèque possède encore : 1° n° $512bis_2$: *Tashīl al-maṭālib fī ta'dīl al-kawākib* (ouvrage qui facilite aux étudiants la détermination de la position des astres), composé par IBN AL-QUNFŪDH pour expliquer un traité d'IBN AL-BANNĀ (*supra* 399) : *al-Yasāra fī ta'dīl al-kawākib al-sayyāra* (non cité par SUTER); 2° n° 531_1 : *Ḥaṭṭ al-niqāb 'alā wajh 'amal al-ḥisāb*, commentaire du *Talkhīṣ* (rectifier le catal. de Rabat où le nom d'IBN HAIDŪR a été mis à tort). — *Ibid.*, p. 171, l. 2. L'indication du commentaire, existant à l'Escurial, n° 911_2 de CASIRI (actuel 916_2), d'une œuvre astrologique d'ABŪ YAḤIĀ AL-MARWĀZĪ (*supra*, n° 96) est fautive; il s'agit du commentaire ci-dessus indiqué de l'*urjūza* d'IBN ABI L-RIJĀL. Le nom d'ABŪ YAḤIĀ ABŪ BAKR B. ABĪ MUJĀHID GHĀZĪ, vizir des sultans mérinides 'ABD AL-'AZĪZ (767-74/1366-72 J.-C.) et MUḤAMMAD III AS-SA'ĪD (774-76/1372-74 J.-C.), a été déformé par CASIRI en « Abū Yahia almeruzi », ce qui a induit SUTER en erreur. Enfin, il est aujourd'hui certain qu'IBN AL-QUNFŪDH est bien le même que le *qāḍī* de Constantine AḤMAD B. AL-ḤASAN B. 'ALĪ IBN AL-KHAṬĪB AL-QUSANṬĪNĪ AL-JIBRITĪ † 810 (1407-08 J.-C.). Bibliographie : *Nail*, 57; *Bustān*, 308; *Nashr*, I, 4 et trad., I, 11; *Jadwa*, 79; *G. A. L.*, II, 241; *Chorfa*, 98, etc. Une liste de ses œuvres dressée par lui-même est reproduite au catal. de Rabat, p. 133.

— 424. [AL-JURJĀNĪ], p. 172, l. 18. Un second exemplaire du commentaire sur le *Mulakhkhas* d'AL-JAGHMĪNĪ (*supra* 403)

est à l'Escurial, n° 967 actuel, et un autre à Rabat, n° 440 (erratum au catal. qui l'attribué à QĀḌĪ ZĀDEH, cf. *infra*, 430).

— 424*a*. [AL-JĀDARĪ]. La *Rawḍat al-azhār* est aussi à l'Escurial, n° 954_{12} actuel, et à Rabat, n^{os} 450_4 et 457_7, sans compter ses nombreux commentaires. L'auteur, né vers 776 (1374-75 J.-C.), habita Fès, où il devint *muwaqqit* de la mosquée-cathédrale d'al-Qarawīyīn. Il a commenté lui-même son poème ci-dessus, sous le titre d'*Iqtiṭāf al-anwār* (la cueillette des fleurs), ouvrage dont il a donné ensuite un abrégé. En outre, il a composé : 1° *Tanbīh al-ānām 'alā mā iaḥduth fī ayyām al-'ām*, sur le calendrier; 2° Commentaire sur l'*urjūza* d'ABŪ MUQRI' (cf. *infra*, 531). Il est mort à Fès en 818 (1415-16 J.-C.), ou, selon d'autres sources, entre 830 et 839 (1426 à 1435 J.-C.). Bibliographie : *Nail*, 146; *Jadwa*, 259; *Salwa*, II, 157; *G. A. L.*, II, 168.

— 426. [IBN ZURRAIQ], p. 173, l. 13. Un exemplaire de son traité sur le quart de cercle à sinus : *al-Nashr al-muṭayyab* est à Rabat n° 449_3. — *Ibid.*, note *a*. On lit au ms. de Rabat : IBN ZURRAIQ AL-JIBRITĪ; sans doute s'agit-il de l'ethnique JABARTĪ (originaire du Somal).

— 428. [AL-RĪSHĪ], p. 173, l. 25. Un exemplaire de son ouvrage intitulé *al-Lam'a fī ḥall as-sab'a* est à Rabat n° 450_7.

— 430. [IBN AL-MAJDĪ], p. 176, l. 3. L'*Irshād al-hā'ir* est à Rabat, n° 452_{10}. — *Ibid.*, l. 19. La *Tuḥfat al-aḥbāb*, sur la *qibla*, est aussi à l'Escurial, n° 970_{10} actuel.

— 435. [AL-ḤABBĀK], p. 177, l. 25. Un exemplaire de la *Bughiat al-ṭullāb* est à Rabat, n° 450_3. En outre, l'auteur a mis en vers la *risāla* d'IBN AL-ṢAFFĀR (*supra* 196) sur l'astrolabe, et composé un commentaire du *Talkhīṣ* d'IBN AL-BANNĀ' (*supra* 399). Bibliographie : *Nail*, 133; *Bustān*, 219; *G. A. L.*, II, 255.

— 444. [AL-QALAṢĀDĪ], p. 181, dernière ligne. Deux exemplaires du *Kashf al-asrār* (var. *astār*) sont à Rabat, n^{os} 455_3 et 456_3. — *Ibid.*, p. 182, l. 17. Un commentaire de l'*urjūza* d'IBN AL-YĀSMĪN (*supra* 320) sur l'algèbre est à Rabat, n° 456_4 (le titre de ce commentaire serait, d'après le ms. n° 770_2 de l'India Office : *Tuḥfat an-nāsīn*). SUTER n'a pas cité le commentaire d'AL-QALAṢĀDĪ, cependant mentionné par AL-MAQQARĪ (Analectes, I, 935) sur l'*urjūza* d'IBN AL-SHARRĀN

(ou SHARRĀZ?) relative au calcul des parts successorales *(farā'iḍ)*, commentaire qui est à l'Escurial, nº 853_6 (le texte seul aux nºs 853_5 et 954_{11} actuels).

— 445. [SIBṬ AL-MĀRIDĪNĪ], p. 183, l. 14. Au nº 963 de CASIRI (actuel 970), la *risāla* sur le quart de cercle à sinus figure deux fois (970_7 et $_{11}$); elle est, en outre, au nº 968_7 actuel; c'est celle qui est appelée aussi *al-fatḥīya* (celle qui ouvre), et dont l'abrégé est très répandu. Elle ne m'a pas semblé différente de la *risālat al-shihābīya* qui est à Alger, nº 1457_5 (cf. *G. A. L.*, II, 168, nº 16). Même ouvrage à Rabat, nºs 441 et 452_8. — *Ibid.*, l. 17. Le traité *Raqā'iq al-ḥaqā'iq* est aussi à l'Escurial, nºs 968_3 et 969_1 actuels. — *Ibid.*, l. 23 et 28. Autre exemplaire du *Zubd al-raqā'iq* à l'Escurial, nº 965_1 de CASIRI (actuel 968_1), et non pas extrait d'*al-Ṭuraf al-sanīya*. — *Ibid.*, p. 184, l. 1. Autre exemplaire du *Ḥāwi l-mukhtaṣarāt* à l'Escurial, nº 970_{13} actuel. Un autre est à Rabat, nº 451_2. — *Ibid.*, l. 3. Au nº 965_3 de CASIRI (actuel 968_4), il ne s'agit pas d'un ouvrage tiré des *Waraqāt* du grand-père de l'auteur (*supra* 421), mais d'un appendice à l'œuvre intitulée *al-ishārāt 'alā rub'al-muqanṭarāt* de SIBṬ AL-MĀRIDĪNĪ, par lui-même, en 10 chap., introduction et conclusion. La glose sur les *Waraqāt* est au nº 970_2 actuel de l'Escurial. — *Ibid.*, l. 6. L'*Iẓhār al-sirr al-mawdū'* est bien à l'Escurial, nº 965_2 de CASIRI (actuel 968_2). — *Ibid.*, l. 9. La *Kifāyat al-qanū'* est à Rabat, nº 449_8. — *Ibid.*, au bas de la page, ajouter les œuvres suivantes : 27. *al-Lu lu' al-mastūr fi l-'amal bi rub'al-dustūr*, en 35 chap. et une introduction, qui est à l'Escurial, nº 968_6 actuel. 28. *Lubb al-mukhtaṣarāt 'alā rub'al-muqanṭarāt*, sur le quart de cercle à parallèles, en 15 chap. avec introduction et conclusion, ouvrage existant à l'Escurial, nº 968_9 actuel, et qui est donné comme extrait du *Naẓm al-la'ālī fi l-'amal bi l-rub'al-shamālī*, du même auteur (ms. du Caire, cat., t. V, p. 237). 29. *Tadrīb al-'āmil bi rub'al-kāmil*, sur le quart de cercle dit « parfait », en 25 chap. et une introduction, qui est à l'Escurial, nº 968_8 actuel.

— 447. [MUḤAMMAD B. ABI L-FATḤ AL-ṢŪFĪ], p. 185, l. 20. Le ms. de l'Escurial nº 926_4 de CASIRI (actuel 931_4) n'est pas consacré au zénith exclusivement; c'est un ouvrage intitulé

'Umdat dhawī al-albāb fī ma'rifat istikhrāj al-'amāl al-falakīya bi l-ḥisāb bi ghair ḥijāb, sur la réalisation des opérations astronomiques au moyen du calcul. — *Ibid.*, l. 22. Le titre de cet ouvrage (10 de SUTER), existant à l'Escurial, n° 931_5 actuel, est : *Bulūgh al-waṭar fi l-'amal bi l-qamar*.

— 451. [IBN GHĀZĪ AL-MIKNĀSĪ], p. 186, l. 33-34. La *Muniat al-ḥussāb* est à Rabat, n° 442; son commentaire : *Bughiat al-ṭullāb*, aux n^{os} 443, 456_2 et 526_1. Il a été lithographié à Fès en 1317 et 1319/1899-1901 J.-C. (*Répert.*, n° 139) avec la glose de MUḤAMMAD BINNĪS (*infra*, 543).

— 470. [AS-SUNBĀṬĪ]. Un exemplaire du commentaire sur la *risāla* de SIBṬ AL-MĀRIDĪNĪ (*supra* 445) traitant du quart de cercle à sinus *(al-fatḥīya* ou *al-shihābīya)* est à Rabat, n° 452_6.

— 493. [IBN BADR]. Il est appelé AL-BALANSĪ (de Valence), et non pas al-Ishbili (de Séville), comme dans CASIRI. Son compendium sur l'algèbre a été publié avec trad. espagnole par J. A. SÁNCHEZ PÉREZ, en 1916. Le nom de MUḤAMMAD B. AL-QĀSIM AL-GHARNĀṬĪ, auteur soi-disant d'un commentaire versifié de cet ouvrage, existant à l'Escurial, n° 931_2), (actuel 936_2), est, en réalité, le nom du maître de l'auteur inconnu du poème en question, et celui-ci n'a rien de commun avec l'œuvre d'IBN BADR.

— 503. [MUḤAMMAD AL-ISHBĪLĪ]. Le commentaire du *Talkhīṣ* d'IBN AL-BANNĀ' existant à l'Escurial, n° 929 de CASIRI (actuel 934), ne se rapporte pas à ABŪ ZAKARIYĀ MUḤAMMAD AL-ISHBĪLĪ, mais à IBN ZAKARIYĀ AL-AWSĪ (*infra* 523).

— 512. [AL-TĀJŪRĪ], p. 201, l. 6. La glose *(hāshiya)* de cet auteur sur la *risāla* de SIBṬ AL-MĀRIDĪNĪ traitant du quart de cercle à sinus (*supra* 445) est aussi à Rabat, n^{os} 452_7 et 455_7. En outre, cette bibliothèque possède, au n° 449_9, une *risāla* sur la boussole *(bait al-ibra)* sous le nom d'AL-TĀJŪRĪ. Bibliographie : *Nail*, 152; *G. A. L.*, II, 358.

— 524. ['ABD AL-RAḤMĀN AL-DALĀ'ILĪ (?)]. Tout ce paragraphe, auteur, œuvre et commentaire, tiré de CASIRI, me paraît des plus suspects.

— 527. [AL-RŪDĀNĪ]. Ce savant marocain, né à Taroudant, dans le Sous, en 1037/1627 J.-C., s'instruisit principalement à Marrakech, puis parcourut l'Algérie, la Tunisie, l'Egypte et la Turquie. Fixé pendant quelque temps au Hedjâz, il

vivait en ascète et interdisait le port des étoffes de laine fabriquées en Europe. En butte à la malveillance, il se réfugia en Syrie et mourut à Damas en 1095/1683 J.-C. Constructeur adroit d'instruments astronomiques (à Marrakech, pour subvenir à ses besoins, il réparait les pendules), il a inventé, au dire d'AL-'AYYĀSHĪ, une sorte d'astrolabe sphérique, sur l'usage duquel il composa un traité. Il a écrit, en outre, un important poème sur l'observation de l'heure. Bibliographie : *Nashr*, II, 81-87, et trad., II, 357 sq.; *G. A. L.*, II, 459.

— 529. ABU L-BAQĀ (ou, pour d'autres, ABU L-ṬAYYIB) ṢĀLIḤ B. 'ALĪ B. SHARĪF B. YAZĪD B. MŪSĀ... AL-RUNDĪ, que CASIRI (I, 379) fait vivre de 601 à 684 (1204-85 J.-C.), est l'auteur d'une *urjūza* sur le calcul des parts successorales *(farā'iḍ)*, existant à l'Escurial, n° 943_9 (actuel 954_{13}). Celle qui la précède dans le même recueil, et que CASIRI (reproduit par SÁNCHEZ PÉREZ, *op. cit.*, p. 136) attribue au même auteur, sous le titre *De temporum cognitione carmen*, n'est autre que la *Rawḍat al-azhār* d'AL-JĀDARĪ (*supra*, 424*a*). L'*urjūza* d'AL-RUNDĪ a été commentée par AL-QALAṢĀDĪ (*supra* 444). Bibliographie : AL-MAQQARĪ, *Analectes*, I, 935 et II, 780.

— 530. IBRĀHĪM B. ABĪ BAKR B. 'ABD ALLĀH B. MŪSĀ AL-ANṢĀRĪ AL-TILIMSĀNĪ, ABŪ ISḤĀQ, né à Tlemçen en 609/1212 J.-C., fut emmené, à l'âge de 9 ans, par son père, à Grenade, puis à Malaga, où il s'instruisit et obtint son diplôme *(ijāza)*. Il vint enfin résider à Ceuta et c'est là qu'il mourut vers 690/1291 J.-C. Traditioniste, poète, juriste versé dans la science des héritages, il est l'auteur d'une célèbre *urjūza* traitant des partages successoraux et connue sous le nom d'*al-Tilimsānīya*; elle comprend 828 vers et fut composée en 635/1328 J.-C. Elle est à l'Escurial, n° 954_4 actuel (CASIRI 943_3 : *De hereditate poema*) et a été lithographiée à Fès (cf. *Répert.* n° 356_8). Il en existe plusieurs commentaires, dont un d'AL-QALAṢĀDĪ (*supra* 444). Bibliographie : *Bustān*, 55; *G. A. L.*, I, 367.

— 531. ABŪ MUQRI' (ou MUQRI'A). On croit, d'après le ms. 361_3 actuel de l'Escurial, que ce personnage est le même que MUḤAMMAD B. 'ALĪ AL-BUṬṬUWĪ (ou mieux BAṬṬIWĪ, des Baṭṭiwa, tribu de la côte du Rîf), qui commanda les troupes du sultan mérinide ABU L-ḤASAN 'ALĪ envoyées en Algérie

en 731-32/1331-32 J.-C. (cf. les références données par DERENBOURG, *op. cit.*, I, p. 235). Il est l'auteur d'une *urjūza* sur le calendrier, maintes fois commentée, notamment par AL-JĀDARĪ et AL-QALAṢĀDĪ (*supra* 424 *a* et 444). Deux autres exemplaires sont à l'Escurial, nos 889_5 et 9541_4 actuels.

— 532. 'ALĪ B. MŪSĀ B. 'ABD ALLĀH B. MUḤAMMAD IBN HAIDŪR AL-TĀDILĪ, savant marocain, dont l'ethnique se rapporte à la province du Tâdla, qui vécut dans la seconde moitié du XIVe siècle et mourut à Fès en 816/1413 J.-C. Il est l'auteur d'un opuscule astrologique existant à l'Escurial, no 911_3 de CASIRI (actuel 916_3) et à Rabat (no 454_4, omis au catalogue), sous le titre d'*al-I'tibārāt al-naẓarīya fi l-aḥkām al-nujūmīya*, et de gloses ou notes sur le *Talkhīs* et le *Raf' al-ḥijāb* d'IBN AL-BANNĀ' (*supra* 399). Bibliographie : *Nail*, 197.

— 533. YAḤIĀ B. MUḤAMMAD B. MUḤAMMAD B. 'ABD AL-RAḤMĀN AL-MAGHRIBĪ AL-RU'AINĪ AL-ḤAṬṬĀB, d'une famille de savants malékites du Hedjâz, né à la Mekke en 902/1496, mort en 954/1547 J.-C. (ou, pour d'autres, seulement vers 1000/1591 J.-C.). Il a composé, comme œuvres scientifiques : 1° *Risāla wasīlat al-ṭullāb li-ma'rifat a'mal al-lail wa l-nahār bi-ṭarīq al-ḥisāb*, sur la détermination des heures des prières, qui serait un abrégé d'un traité de son père; il existe à Berlin, no 5700 et à Rabat, no 449_{11}. 2° *Risāla fī ma'rifat istikhrāj a'mal al-lail wa l-nahār bi-rub' al-jayb*, sur l'emploi du quart de cercle à sinus pour la même détermination, opuscule tiré des œuvres de SIBṬ AL-MĀRIDĪNĪ (*supra* 445); existe à Berlin, no 5826, Rabat, no 449_5 et au Caire, cat., t. V, p. 252 (celui qui figure deux pages auparavant, en 10 chap., me paraît être du père de l'auteur); commentaire anonyme à Berlin, no 5827 et Rabat, no 449_6. Bibliographie : *Nail*, 394, *G. A. L.*, II, 393.

— 534. AḤMAD B. ḤUMAYDA AL-MUṬARRIFĪ † 1001/1592 J.-C., à Marrakech est un des maîtres d'IBN AL-QĀḌĪ (*infra* 536); il avait été lui-même, pendant son voyage en Orient, l'élève d'AL-TĀJŪRĪ (*supra* 512). On lui doit un commentaire de la *Rawḍat al-azhār* d'AL-JĀDARĪ (*supra* 424*a*), qui est à Alger no 613_2 (l'auteur y est appelé Abū Ḥamīda). Bibliographie : *Nashr*, I, 22, et trad., I, 49; *Jadwa*, 83.

— 535. 'ABD AL-RAḤMĀN B. 'UMAR B. AḤMAD AL-SŪSĪ AL-JAZŪLĪ

AL-BU'QĪLĪ (ou BŪ'AQILĪ), ABŪ ZAYD, qui vécut à Marrakech dans la seconde moitié du XVI[e] siècle et mourut en 1020/1611 J.-C., est l'auteur d'un commentaire, très répandu au Maroc, de la *Rawḍat al-azhār* d'AL-JĀDARĪ (*supra* 424*a*) intitulé : *Qaṭf al-anwār* (la cueillette des fleurs); il existe à Rabat et a été lithographié à Fès (*Répert.*, n° 229). Bibliographie : *Nashr*, I, 110, et trad., I, 236; *Ṣafwa*, 44; *Sa'āda*, II, 129.

— 536. AḤMAD B. MUḤAMMAD... B. ABI L-'ĀFIYA AL-MIKNĀSĪ AL-ZANĀTĪ, SHIHĀB AL-DĪN, connu sous le nom d'IBN AL-QĀḌĪ, né en 960/1553, mort à Fès en 1025/1616 J.-C., est surtout connu comme littérateur et historien. Il a cependant produit quelques œuvres scientifiques : 1° *al-Madkhal fi l-handasa*, introduction à la géométrie. 2° Mise en vers du *Talkhīṣ* d'IBN AL-BANNĀ' (*supra* 399); 3° *Ghuniat al-rā'id fī ṭabaqāt ahl al-ḥisāb wa l-farā'iḍ*, sur les classes de savants versés dans les mathématiques et les partages successoraux, ouvrage que nous ne possédons malheureusement pas. Bibliographie : *Idjâza*, § 307; *Chorfa*, 100 sq. et les sources citées.

— 537. 'ALĪ B. MUḤAMMAD B. ABI L-QĀSIM [MUḤAMMAD] B. IBRĀHĪM... AL-DĀDISĪ, originaire de la région du Dadès, dans l'extrême-sud marocain, vécut au XVII[e] siècle à Fès, où il remplit les fonctions de *muwaqqit*, puis au Caire, où il mourut en 1094/1683 J.-C. On lui doit divers poèmes concernant le calcul astronomique de l'heure : 1° *al-Yawāqīt* (les rubis) *li-mubtaghī* [var. *li-ṭālib*] *ma'rifat al-mawāqīt*, qu'il commenta lui-même sous le titre de *Fatḥ al-muqīt* (rac. *Q. W. T.*); le texte existe au Caire, cat., t. V, p. 330; le texte et commentaire à Londres, n° 411_3, Alger, n° 1486 et Rabat, n° 446, où le titre est *Ikmāl fatḥ al-muqīt* (mais l'attribution au poète AL-ḤĀ'IK me parait erronée). 2° *Bidāiat al-ṭullāb fī 'ilm waqt al-yawm bi l-ḥisāb*, avec commentaire intitulé *Itḥāf dhawi l-albāb*, existant à Londres, n° 409. 3° *Ma'ūnat al-ṭullāb*, sur les saisons, d°, n° 410, avec commentaire de 'ALĪ B. SULAYMĀN B. YA'IZZ AL-TAGHANĀSĪ (je n'ai pas de renseignements sur cet auteur). Bibliographie : *Ṣafwa*, 198; *Nashr*, II, 127, et trad., II, 455; *G. A. L.*, II, 463.

— 538. AḤMAD B. MUḤAMMAD B. MŪSĀ AL-FĀSĪ, dit ḤAMDŪN AL-ABBĀR (le marchand d'aiguilles), lettré marocain et philo-

sophe soufi, né en 1001/1592-93, mort en 1071/1660-61 J.-C., fut *khāṭib* (prédicateur) de la mosquée d'al-Andalus à Fès et l'un des maîtres d'AL-'AYYĀSHĪ. Il a laissé sur la science des partages successoraux un petit ouvrage intitulé *Kashf al-riwāq* (l'enlèvement du rideau) *'an ṣarf al-jāmi'a li l-awāq*, qui est à Rabat n^{os} 457_2 et 539_2. — Bibliographie : *Nashr*, I, 228, et trad., II, 107; *Chorfa*, p. 263, note 3.

— 539. MUḤAMMAD B. AḤMAD B. MUḤAMMAD IBN AL-ṢABBĀGH AL-'UQAILĪ (ou AL-BŪ'AQILĪ) de Meknès, né dans les dernières années du XVI^e siècle, d'une famille d'origine andalouse, étudia à Fès, où il fut l'élève d'IBN AL-QĀḌĪ (*supra* 536). C'est là qu'il mourut, en 1076 /1665-66 J.-C. Il est connu comme traditioniste, juriste, astronome et mathématicien. Ses ouvrages scientifiques sont : 1° *Idrāk al-bughia li-ḥall alfāẓ al-Munia*, importante glose sur la *Munia* d'IBN GHĀZĪ (*supra* 451); existe à Rabat, n° 444. 2° *Silk al-farā'id al-yawāqīt fi l-ḥisāb wa l-farā'iḍ wa l-mawāqīt*, sur le calcul des parts successorales, lith. Fès, 1319 Heg. (*Répert.*, n° 163). 3° Commentaire de la *Rawḍat al-azhār* d'AL-JĀDARĪ (*supra* 424*a*). Bibliographie : *Ṣafwa*, 145; *Salwa*, I, 239.

— 540. MUḤAMMAD B. SA'ĪD AL-SŪSĪ AL-MARGHĪTHĪ (ou MIRGHĪTHĪ) né en 1007/1598-99 J.-C., vécut principalement à Marrakech, où il fut *imām* de la mosquée d'al-Mawâsin; il y mourut en 1089/1678 J.-C., au cours de la grande épidémie de peste. C'est l'auteur d'un poème célèbre sur le calcul des heures et le calendrier : *al-Muqni' fī ikhtiṣār 'ilm Abī Muqri'* (supra 531), dont il existe de nombreux mss. : Berlin 5707; Gotha 1456; Alger 80_2, 376_9, 394_6, 399_2, etc., Rabat 450_3. AL-MARGHĪTHĪ a fait lui-même deux commentaires de ce poème : 1° *al-Mumti'*, développé, qui est à Berlin 5708; Londres 411 et 412; Munich 728; Alger, 673_9 959_2, etc.; Rabat 499_3 et 510_5; il a été lithographié à Fès (avec le *Muqni'* en marge) en 1313/1895-96 J.-C., et à diverses reprises (avec le commentaire d'AL-WARZĪZĪ; cf. *Répert.*, n° 94). 2° *al-Muṭli'*, résumé, qui est à Berlin 5709; Gotha 1456_2; Alger 1484_1, et lith. Fès s. d. (*Répert.*, n° 323). Un petit poème sur le quart de cercle à sinus, intitulé : *Ma'ūnat al-ḥaisūbī fī 'amal al-tawqīt bi l-juyūb(i)* existe à Rabat, n° 455_6, sous le nom d'AL-MARGHĪTHĪ. Enfin, il est cité comme l'auteur d'un poème

sur le pentacle *al-jadwal al-mukhammas* et d'un autre sur l'astrologie. Bibliographie : *Ṣafwa*, 177 sq.; *Nashr*, II, 37, et trad., II, 274; *G. A. L.*, II, 463,; *Chorfa*, 260 sq.

— 541. 'Abd al-Raḥmān b. 'Abd al-Qādir al-Fihrī al-Fāsī, Abū Zayd. C'est un des plus remarquables polygraphes marocains, né à Fès en 1040/1631 J.-C., d'une famille de savants et de docteurs de l'Islâm. Il était célèbre pour sa mémoire prodigieuse et la variété de ses connaissances. On lui prête plus de 170 ouvrages, dont les suivants seulement intéressent les sciences : 1° *K. al-uqnūm fī mabādi l-'ulūm*, grande encyclopédie scientifique *(sensu lato)*, en 281 sections, sous forme d'*urjūza*, existant en manuscrit à Rabat, n^{os} 284 à 286. 2° *Nukhbat al-ṭullāb fī 'amal al-usṭurlāb*, de 118 vers, qui est à l'Académie orientale de Vienne, n° 334 et à Rabat, n^{os} 453$_3$, 457$_6$ et 497$_{14}$. 3° *al-Maṭlab fī rub' al-mujayyab*, sur le quart de cercle à sinus; Vienne (d°) n° 333. 4° *Wafiyat al-maṭlūb*, sur le même sujet (?); ibid., n° 332. 5° *'Iqd al-jawhar*, sur le quart de cercle à parallèles; Berlin, n° 5867 et Rabat n° 457$_6$*bis* (omis au catalogue), 151 vers. 6° *al-Ghurra fi l-kalām 'alā bayt al-ibra*, sur la boussole; Vienne (d°) n° 336 et Rabat n° 450$_6$. 7° Poème sur la division du ciel et l'emploi des quarts de cercle (d'après Brockelmann); Vienne (d°), n° 343. 8° *al-Dībāj al-marqūm fī uṣūl 'ilm al-nujūm*, sur l'astrologie, 264 vers; Berlin n° 5887. 'Abd al-Raḥmān al-Fāsī, devenu paralytique vers la fin de sa vie, est mort à Fès en 1096/1685 J.-C. Bibliographie : *Idjâza*, § 3; *Chorfa*, 226 et les sources citées; *G. A. L.*, II, 460 et 463.

— 542. Aḥmad b. Sulaymān al-Jazūlī al-Rasmūkī, juriste et mathématicien, vécut dans la seconde moitié du XVII^e siècle à Marrakech. Il est surtout connu par ses poèmes et commentaires sur les partages successoraux : 1° *al-Jawāhir al-maknūna fī ṣadaf al-farā'iḍ al-mansūba*, poème qu'il a lui-même commenté plusieurs fois; un de ces commentaires, intitulé : *Iḍāḥ al-asrār al-masnūna* est à Rabat, n° 225. 2° Complément de 120 vers à l'*urjūza* de 34 vers d'Ibrāhīm b. abi l-Qāsim al-Samlālī (je n'ai pas encore de renseignements sur cet auteur) intitulée *Ajniḥat al-ghurāb* (les ailes du corbeau) *fī ma'rifat al-farā'iḍ wa l-ḥisāb*, qui est à Rabat, n° 510$_3$. 3° Commentaire sur le précédent (et son complément) sous

le titre de *Miftāḥ ajniḥat al-ghurāb*; Rabat, n° 457, et lith. Fès, 1322 Heg. (*Répert.* n° 199). 4° Autre commentaire, mot à mot, du même poème, sous un nouveau titre : *Ma'ūnat al-aḥbāb 'alā fatḥ ajniḥat al-ghurāb*, qui est à Rabat, n° 504_6. 5° Commentaire de la *Rawḍat al-azhār* d'AL-JĀDARĪ (supra 424*a*). 6° Commentaire des 8 vers d'ABU L-'ABBĀS AL-SABTĪ sur l'usage de la *zairja*. AL-RASMUKĪ est mort à Marrakech en 1133/1720-21 J.-C. Bibliographie : *Ṣafwa*, 86; *Sa'āda*, I, 126.

— 543. SULAYMĀN B. AḤMAD AL-FISHTĀLĪ, ABU L-RABI', qui fut *muftī* et *qāḍī* de Fès au XVIII^e^ siècle, était versé dans la science du calcul des heures et des positions des astres, *'ilm al-mīqāt wa t-ta'dīl*, « au moyen des instruments et sans leur secours ». Il fut, dans ces questions, le maître du lettré réputé SULAYMĀN AL-ḤAWWĀT (cf. *Chorfa*, 336 sq.). On lui doit : 1° *Bughiat dhawi l-raghbāt*, sur les difficultés de la *risālat al-fatḥīya* de SIBṬ AL-MĀRIDĪNĪ (*supra* 445), lith. Fès, 1317 Heg. (*Répert.*, n° 140). 2° Opuscule sur la tablette universelle *al-ṣafīḥat al-jami'a* d'IBN BĀṢ (sic; cf. *supra* 381*b*.), Rabat n° 452_3. Il mourut à Fès en 1208/1794 J.-C. Bibliographie : *Salwa*, III, 115.

— 544. MUḤAMMAD B. AḤMAD B. MUḤAMMAD BINNĪS (vulg. BENNĪS), est encore un lettré marocain versé dans les sciences exactes et le calcul des héritages. Né à Fès en 1166/1753 J.-C., il y est mort au cours de la grande épidémie de peste de 1213-14/1798-1800 J.-C. Ce fut l'un des maîtres du sultan MOULAY SLIMAN. On lui doit une glose sur la *Bughia* d'IBN GHĀZĪ (*supra* 451), intitulée *Nuzhat dhawi l-albāb wa tuḥfat nujabā' al-anjāb*, et qui a été lithographiée à Fès en 1317/1899-1900 J.-C., en marge du commentaire d'IBN GHĀZĪ (*Répert.*, n° 139). Bibliographie : *Salwa*, I, 204.

Institut des Hautes Études marocaines.

H. P. J. RENAUD.

Directeur d'études d'Histoire des sciences chez les peuples musulmans.

The relation between pure and applied electrical theory : with special reference to mathematical methods (*)

The history of electrical theory contains many examples of the manner in which pure science has produced discoveries of great practical importance. It is the object of the present paper to trace, by means of an historical retrospect, some of the more important of these developments.

There is an unfortunate deviation between the views of the theorist and the practitioner concerning the usefulness of theoretical investigations. A study of the history of electrical theory shows that in reality these two classes are closely related; the progress of electrical practice having its foundation in pure theory.

One of the greatest discoveries in electrical history was the observance by OERSTED in 1820 of the magnetic effect of an electric current. HANS CHRISTIAN OERSTED (1777-1851) was Professor of Natural Philosophy in Copenhagen. As early as 1807 he announced his intention of examining the effects of an electric current upon the ordinary magnetic needle. We are told that he was not a very able experimenter, and was obliged to rely upon an assistant for the arrangement of his experiments. Many years elapsed before the advent of his discovery, which took place during a course of lectures which he delivered at Copenhagen in the winter of 1819-1820, on ' Electricity, Galvanism, and Magnetism'. During these lectures he observed that a wire carrying current from a battery affected a compass needle in its vicinity in such a manner that the needle tended to set itself at right-angles to the wire so long as a current flowed. The

(*) Presented to the Second International Congress of the History of Science and Technology, London, July 3, 1931.

results of this discovery were published by OERSTED in a tract entitled *Experimenta circa effectum Conflictus Electrici in Acum Magneticam* dated July 21st 1820. (1)

OERSTED's experiments were soon repeated in France, with the result that a detailed analysis of the effect was announced by JEAN-BAPTISTE BIOT (1774-1862) and FÉLIX SAVART (1791-1841) at a meeting of the Academy of Sciences on October 30th 1820. The subject also engaged the attention of ANDRÉ MARIE AMPÈRE (1775-1836) who, after three years research, published the results of his investigations in a mathematical memoir which will ever remain among the classics of electrical theory. This memoir contains the first conception of the ' magnetic shell ' which is of such great importance in electromagnetic theory, and an expression for the force between two current elements which established the laws of mechanical action between electric currents. In his famous *Treatise on Electricity and Magnetism* JAMES CLERK MAXWELL (1831-1879) refers to AMPÈRE's memoir as follows : « The whole, theory and experiment, seems as if it had leaped, full grown and full armed, from the brain of the ' NEWTON of electricity '. It is perfect in form, and unassailable in accuracy, and it is summed up in a formula from which all the phenomena may be deduced and which must always remain the cardinal formula of electrodynamics ».

OERSTED's experiments had shown that electricity produces magnetism. It was now natural to enquire whether magnetism could produce electricity; a question which was answered by MICHAEL FARADAY in his discovery of the phenomenon of electromagnetic induction. This discovery took place on August 29th 1831, and the present year therefore marks its centenary. The discovery was made with an electromagnet consisting of a soft iron ring upon which two independent coils were wound; one coil being connected to a battery and the other to a galvanometer. In his paper presented to the Royal Society on November 24th 1831, FARADAY describes his discovery as follows : « When the contact was made, there was a sudden and very slight effect on the galvanometer and there was also a similar slight effect

(1) Facsimile in *Isis*, 10, 435-40. There is a German trans. from the Latin in OSTWALD's *Klassiker*, Nr. 63, « Zur Entdeckung des Elektromagnetismus », and English trans. in THOMSON's *Annals of Philosophy*, 16 (1820), p. 273.

when the contact with the battery was broken. But whilst the voltaic current was continuing to pass through the one helix, no galvanometrical appearance nor any effect like induction upon the other helix could be perceived ».

Just as the work of OERSTED had been advanced by the mathematicians BIOT, SAVART and AMPÈRE, so also was the work of FARADAY advanced by the English mathematicians of the nineteenth century. Chief among these were Sir WILLIAM THOMSON (Lord KELVIN) (1824-1907) and JAMES CLERK MAXWELL, who had both studied FARADAY's experimental researches and had noted therein the clarity and logic of his deductions.

In a paper which he published at Cambridge when seventeen years of age, Lord KELVIN (then WILLIAM THOMSON) compared the distribution of electrostatic force to the distribution of heat flow in an infinite solid. This analogy had been anticipated some five years previously by the French geometer, MICHEL CHASLES (1793-1880), in a memoir published in 1837. In 1846 THOMSON published a further paper having as its subject the analogy between certain electrical phenomena and elasticity. From an examination of the equations of equilibrium of an incompressible elastic solid in a state of strain he showed that the distribution of the elastic displacement was analogous to the distribution of electric force in an electrostatic field.

Lord KELVIN's ability in devising mechanical models and analogies was characteristic of the Cambridge school of thought. It was shared also by CLERK MAXWELL, who published his first mathematical interpretation of the conceptions of FARADAY in a paper (2) presented to the Cambridge Philosophical Society when twenty-four years of age, and shortly after his election to Fellowship of Trinity College. In MAXWELL was vested the rare combination of a first class mathematical ability and a keen insight of physical phenomena, which enabled him not only to grasp the conditions underlying an experiment but also to express these conditions in mathematical language. He made a thorough study of FARADAY's ' Experimental Researches ' and resolved to bring them to the notice of contemporary mathematicians by translating them into a mathematical form. In his first memoir

(2) *Trans. Camb. Phil. Soc.*, 10, p. 27.

MAXWELL attempted to identify the ideas of FARADAY with the analogies devised by KELVIN. By identifying FARADAY's 'lines of force' with the lines of flow of a liquid he was able to show that the magnetic induction is expressible as the velocity of an incompressible fluid.

The prosecution of these methods of enquiry led MAXWELL to formulate his famous dynamical theory of electromagnetism and the 'MAXWELL Equations' which have played such an important part in the mathematical theory of electricity. MAXWELL's *Treatise on Electricity and Magnetism* which was first published in 1873, represents a complete development of his earlier attempts at a mathematical interpretation of FARADAY, and may be regarded as the groundwork of electrical theory as it is known to-day. It stands in itself as one of the greatest tributes to FARADAY as a natural philosopher. The work of FARADAY and MAXWELL, carried on in the spirit of discovery for the furtherance of pure knowledge, and without any heed to the possibilities of practical application, has provided the practitioner with the materials from which has been created the whole of electrical engineering practice.

The theory of signalling by cable originated in a correspondence between Lord KELVIN and Sir GEORGE GABRIEL STOKES (1819-1903) in 1854. The work of KELVIN on this subject was extended in 1857 by GUSTAV ROBERT KIRCHHOFF (1824-1887), who showed that the electromagnetic disturbance is propagated with a definite velocity, C. The value of this constant had been determined previously by WILHELM WEBER (1804-1890) and RUDOLPH KOHLRAUSCH (1809-1858) who showed by a comparison of two different methods of discharging a Leyden jar that $C = 3.1 \times 10^{10}$ cm./sec. approximately. This is very close to the value of the velocity of light as determined by astronomical observations. The average of three independent observations of the velocity of propagation of electromagnetic waves in air—TROWBRIDGE and DUANE (1895), SAUNDERS (1897), and MACLEAN (1899), is 2.997×10^{10} cm./sec. The measurement of the velocity of light by the late A. A. MICHELSON in October, 1924, gave the value 2.99735×10^{10} cm./sec., with a possible error of one part in 22,000. The close agreement between the velocity of light and the velocity of electromagnetic waves was observed by MAXWELL, and was regarded by him as a strong reason for believing that light is an electromagnetic

phenomenon. To MAXWELL is due the electromagnetic theory of light, concerning the scientific importance of which the present state of optical theory does not permit us to speculate.

An outstanding example of the relationship between pure and applied electrical theory is afforded by the modern theory of electrons founded by Sir J. J. THOMSON at Cambridge towards the end of last century. This highly abstract theory is one of the last from which we would anticipate the emergence of practical utility, and yet the electron has made possible the conveyance of wireless messages with a consequent inestimable value to mankind. The use of X-rays in surgery and medicine has enormously improved these sciences to the benefit of the human race. In the words of Sir J. J. THOMSON ' These discoveries were made without any thought of such applications; they illustrate the value of research made solely for the purpose of advancing knowledge. It is discoveries made in this way that create new industries and revolutionise old ones '.

Just as the practitioner builds upon the results of the research worker, so also does the research worker and theorist depend greatly upon the pure mathematician for the weapons of analysis with which to achieve his results.

Electrical theory provides many examples of this dependence.

Modern electrical theory makes use of a very large portion of the domain of pure mathematics. In alternating current circuit theory and in certain problems of electrostatics involving a two dimensional form of LAPLACE's equation, much assistance is derived in practice from the use of so-called ' complex quantities ', relying for their physical interpretation upon the unassignable square root of minus one. (3) The origin of these purely mathematical conceptions goes back far into the history of mathematics (4), and their development has, strangely enough, often been in advance of strict mathematical logic : Nevertheless they have proved of great practical value; they have rendered possible

(3) See the author's papers : « Complex numbers in Engineering » *The Electrician*, 98, pp. 142-145 : « The Complex number and its use in Electrical Theory » *ibid.*, CI, pp. 173-174, 201-203. « Electrical Circuit Theory based on the method of Complex Numbers » *ibid.*, 102, pp. 409-411, 437-438.

(4) G. WINDRED, « History of the Theory of Imaginary and Complex Quantities », *Mathematical Gazette*, 14, Oct. 1929, pp. 533-541.

the solution of otherwise insoluble problems of great importance in electrical circuit theory, the theory of electrostatics, and analogous problems in hydrodynamics.

The first application of complex quantities to a practical problem in electric circuit theory seems to have been made by HERMAN VON HELMHOLTZ (1821-1894) in a paper on telephone theory published in WEIDEMANN's *Annalen der Physik und Chemie* in 1878. (5) The method of complex quantities was also employed extensively by OLIVER HEAVISIDE (1850-1925) notably in a series of papers *On the Self-Induction of Wires* published in 1886 and 1887. Further applications of the method were made by ADOLF FRANKE in a paper on the theory of telephone networks published in 1891. (6)

In 1893 the method of complex quantities was applied to the general theory of alternating current circuits by ARTHUR EDWIN KENNELLY, whose paper on « Impedance » published in the *Transactions* of the American Institute of Electrical Engineers for April, 1893, contains the first application of complex representation to electrical technology. The methods here instituted were developed, notably by Dr. CHARLES PROTEUS STEINMETZ (1865-1923), and have become of fundamental importance in the general theory of alternating current circuits and in the solution of transmission line problems. (7) Thus we have an outstanding example of the practical application of a branch of pure mathematics, which was developed during several centuries without the thought of ever being applied for utilitarian purposes.

A study of scientific history makes it evident that there can be no independence between pure research and experiment on the one hand, and the practical application of scientific principles on the other hand. Each branch depends for its development upon the other. Neither can we regard pure mathematics as distinct and apart from scientific developments : It has given us some of the most valuable theories which we possess. To use a simile of Sir J. J. THOMSON : « The mathematical method

(5) « Telefon und Klangfarbe », Band 5, p. 448.

(6) « Die elektrischen Vorgänge in Fernsprechleitungen und Apparaten «, *Elektrotechnische Zeitschrift*, 1891, pp. 447, 458.

(7) G. WINDRED, « Early Developments in A. C. Circuit Theory », *Phil. Mag.*, 10, Nov. 1930, pp. 905 seqq.

is the better for developing ideas, the physical for originating them; the mathematical, so to speak, is the better incubator, the physical the more prolific hen; both are essential ».

The present tendency of intense specialisation makes the progress of Science more than ever dependent upon the coordination of pure and applied theory which can be achieved only through close collaboration between the pure theorist and the practitioner.

Bedford, Engl. G. WINDRED.

Notes and Correspondence

I. Miscellanea.

Guyton de Morveau (1737-1816). The statement (*Isis*, 11, 196, 1928) that GUYTON, during an epidemic of infectious fever caused by the exhumation of corpses at Dijon, used fumigations of " acide marin déphlogistiqué (chlore) " in 1773 is certainly incorrect, since chlorine was not discovered until 1774. The account given by THOMSON (System of Chemistry, 5 ed., vol. 2, p. 255, 1817) states, no doubt correctly, that GUYTON used fumes of hydrochloric acid (muriatic acid) to purify the cathedral of Dijon which, in 1773, was so infected by putrid exhalations that it was deserted altogether after several unsuccessful attempts to purify it. " Having poured two pounds of sulphuric acid on six pounds of common salt, contained in a glass capsule, which had been placed on a few live coals in the middle of the church, he withdrew precipitately, and shut all the doors. The muriatic acid gas soon filled the whole cathedral, and could even be perceived at the door. After twelve hours, the doors were thrown open, and a current of air made to pass through to remove the gas. This destroyed completely every putrid odour." There is no mention of " infection."

J. R. PARTINGTON.

Gunpowder. The quotation from LIPPMANN's paper in *Isis*, 11, 429, 1928 to the effect that a notice about gunpowder in Florence in 1326 is " die erste sichere urkundliche Bezeugung " of this kind, does not take us very far. Earlier notices are quoted by HIME (Origin of artillery, London, 1915—a later " authority " than DAVIDSOHN, p. 120 ff.), who goes carefully into the whole matter. The date of the invention of gunpowder has nothing to do with the date when saltpetre was first known.

J. R. PARTINGTON.

II. History of Science.

California. — Dr. and Mrs. CHARLES SINGER of London have returned to Berkeley where they will again offer special work associated with the history of science at the University of California. Professor SINGER will give an advanced course, from January to May, 1932, on the history of biology and its general relations to the history of science and civilization. He will also give a special seminar course on the special phases of history of science. Mrs. SINGER will carry on special work with advanced students.

The Historical Section of the Lane Medical Library, San Francisco, was dedicated January 11, 1932. Remarks were made by Dean WILLIAM OPHÜLS and Professor EMMETT RIXFORD on the origin and background of the Historical Section, and Dr. HENRY E. SIGERIST, Professor of the History of Medicine at the University of Leipzig, delivered an address on the " Relation of History of Medicine to Practice." Professor SIGERIST delivered two other lectures at Stanford Medical School, San Francisco, and also at Stanford University, Palo Alto.

On January 19, 1932, Professor SIGERIST lectured at the University of California Medical School, San Francisco, on the " Evolution of Medical Ethics," and on January 20, at the University of California, Berkeley, on " Civilization and Disease."

A special dinner was given in honor of Dr. and Mrs. SINGER, and of Professor SIGERIST by the California Medical History Seminar on January 18, at which time a general discussion was held on methods and problems of instruction and research in medical history.

Reviews

P. Paul Szczygiel. — *Das Buch Job, uebersetzt und erklaert.* VIII + 258 p. Bonn, PETER HANSTEIN Verlagsbuchhandlung, 1931. (RM. 9.20, bound in linen, RM. 11.20).

Modern Bible exegesis and Bible criticism received a powerful impulse from Reformation and Protestantism. The main results in this science were achieved in Protestant countries and by Protestant scholars. In the last fifty years, there is to be noticed in Catholic schools too a come back to the Bible and a revival of the Bible studies. Once undertaken, it is impossible to shut out the scientific methods of modern philology and historical criticism.

The book of SZCZYGIEL is a part of the so called Bonn Bible. This is an undertaking of a new German Bible translation with commentaries sponsored by the Catholic Theological Faculty of the University at Bonn on the Rhine, Germany. The name is : *Die Heilige Schrift des Alten Testaments*, uebersetzt und erklaert in Verbindung mit Fachgelehrten, herausgegeben von Dr. FRANZ FELDMANN und Dr. HEINR. HERKENNE, Professoren der Theologie an der Universitaet Bonn. SZCZYGIEL's books is provided with the stamp of *Imprimatur* by the authorities of the Catholic Church, and in the selected bibliography, pp. 1-2, a distinction is made between Catholic and non-Catholic literature. The whole undertaking thus represents a laudable effort of the Catholic Church to cope with the problem of modern Bible interpretation.

The translation of SZCZYGIEL is based upon the Hebrew edition of the text by G. BEER in KITTEL's *Biblia Hebraica*, which gives the critical apparatus of variants and emendations. For the Greek Septuagint SWETE's edition was used. According to the program of the Bonn Bible, Hebrew type is entirely omitted. Hebrew words are cited only in transcription, and discussions of a purely philological nature, or referring to textual criticism are restricted to a minimum. The book is headed by an elaborate and very instructive introduction which contains the following items : 1. A selected bibliography. 2. The contents. 3. Purpose of the book. 4. The problem. 5. The picture of a trial by court. 6. Historicity and date of the story. 7. Names and native countries of

the persons. 8. Origin and unity of the book. 9. The genuineness of special chapters. 10. The Elihu discourses. 11. Date and place of the author. 12. The canonic character of the book. 13. Textual criticism, translations. 14. The author explains his method of translation.

It seems to the reviewer that SZCZYGIEL goes too far in rejecting the Masoretic text and adopting unnecessary, highly improbable emendations. A few examples may suffice for illustration. The verse 38,1, is translated : " Da stand Jahwe dem Job Rede, der den Sturm bestimmt, sagte." SZCZYGIEL reads : *mōneh se'arah*, instead of the Masoretic : *min ha-se'arah*. That is impossible. Even if the Masoretic text would read : *mōneh se'arah*, I would correct it into : *min ha-se'arah*. 38,7, is given : " Durch meinen Jubel freuen sich die Morgensterne." He emendates : *beronni yiḥad*, instead of the Masoretic *beron yaḥad*. Again an entirely unnecessary and impossible emendation of a smooth, intelligible text (1).

Highly improbable is also the placement of chapter 28 after 42,6. A special investigation of this chapter with regard to the history of mining would be very desirable (2).

Sometimes the attempt is made by SZCZYGIEL to read into the text ideas and conceptions that are not there and that belong to a much later stage of religious thought. So he says (on p. 11) : " Er (Job) gewann einen tieferen Einblick in Gottes Wesenheit und Walten und errang die Erkenntnis, dass die Freundschaft Gottes das beseligende Alles ist... Das wahre Glueck des Gerechten besteht nicht im Besitz der aeusseren Gueter, in Gesundheit, langem Leben und Wohlergehen,... sondern in der lebendigen Erfassung Gottes und im Glueck der inneren Gotteskindschaft. Gegen diesen inneren Reichtum bedeuten alle irdischen Gueter nichts." The reviewer must confess that he was unable to find in the text of Job any basis for such a statement. We read in the concluding chapter : " And the Lord changed the fortune of Job and gave him twice as much as he had before : Fourteen thousand sheep, and six thousand camels, and a thousand yoke of oxen and a thousand she asses. He had also seven sons and three very beautiful daughters etc." These are very material and earthly things. But there is not one word in the epilogue, or in the whole book, about Job's resignation of the earthly things and his contentedness with the inner riches of the soul, or with the blessings of the " Gotteskindschaft."

The problem of Job is still with us. The righteous suffer and are

---

(1) The relation of 38,4-7, to Egyptian ceremonies was discussed in my paper " Die Harpedonapten oder Seilspanner und Seilknuepfer " in *Quellen und Studien zur Geschichte der Mathematik*, B. 1. pp. 260-64.

(2) See SARTON, *Introduction to the History of Science*, I, p. 90.

humiliated, and the wicked prosper and are triumphant. Only a very few, the great minds and the noble souls, are able to find solace and happiness in their inner soul, in the spiritual goods of religion and science. From the great masses loudly resounds Job's cry for justice. Upon its happy solution rests the future of our civilisation.

SOLOMON GANDZ.

Anna Montgomery Campbell. — *The Black Death and Men of Learning.* XII + 210 pp. Columbia University Press, New York, 1931. $ 3.00.

Professor CAMPBELL is to be congratulated on a scholarly contribution, and the Carnegie Corporation of New York for making its publication possible. It is the first of a new series supported by a fund generously donated by the Carnegie Corporation to the History of Science Society to enable the Society to publish important contributions to knowledge. Chairman G. S. BRETT of the Society's Publications Committee states in an introductory note : " The works of scholars and other documents of historical or scientific value are often not sufficiently remunerative to secure acceptance by publishers, who must consider the probable returns on the investment. The support of such an institution as the Carnegie Corporation gives an opportunity to publish works of this kind. A high standard of scholarship and intrinsic merit is maintained by submitting the proposed publications to competent judges. The work of Miss CAMPBELL is the first book to be produced by the aid of the fund at the disposal of the Society, and other important publications will be issued as soon as possible." May all subsequent volumes in the series rival the excellence of the first !

" The object of this study is to treat the Black Death (1347-1350) only as it affected the intellectual classes, and the fields of learning in which they labored. Medicine and education, especially the universities, are emphasized, since plague tractates of the period and university records furnish the best source material."

Dr. CAMPBELL begins her study by a catalogue and analysis of the 16 known plague tractates of 1348-1350. " Two of them, the Parisian *Consultation* and the Strasburg *Treasure of Wisdom*, are the oldest extant medical documents of, respectively, the Faculty of Medicine at Paris and the City of Strasburg." It is also significant that two were written by the Spanish Arabs, IBN KHĀTIMAH and IBN AL-KHATIB (1313-1374). The former upheld the orthodox view of non-infection, but the latter stressed the obvious existence of infection. One of the most sensible of these tracts was the *Consilia contra pestilentiam* of GENTILE DA FOLIGNO, who himself died of it on June 18, 1348.

" The subject matter of the treatises is usually divided into considerations of the causes of the pestilence, its prevention, and cure ; the last of the three is ordinarily stressed less than the other two for the reason, as several of the writers remark, that the disease almost always has a fatal termination." It is noteworthy that an astrological etiology was emphasized most strongly by the *Consultation* of the Paris Faculty. Although some preventive measures were suggested against pollution of the air and infection, most were pathetically directed toward fortifying the body by food, drink, exercise, bathing, and sleep. The universal presence of filth, rats, vermin and fleas probably precluded consideration of these factors in etiology or prevention, although AVICENNA had noted " that a sign of pestilence was when mice and animals living under the ground fled to its surface and were disturbed as if they were drunk ; and observations of disturbance in the animal world are made by several fourteenth century writers."

Mortality from the plague among physicians of the period is hard to estimate. It definitely inaugurated a period of medical advance, and most importantly it gave the impetus to the restoration of surgery to a respectable status. Postmortem examinations, leading to dissections, were authorized in the effort to get information on the cause and treatment. Quarantine regulations were invented, and sometimes drastically enforced. The very full series of ordinances against the plague issued by the city of Pistoia in May and June, 1348 are well discussed in this connection.

While the most important effects of the Black Death in intellectual fields other than medicine were reflected in loss of morale (especially in the clergy) and in actual deaths, there was considerable stimulation of interest in astrology. This vented itself chiefly in prognostications of future epidemics.

" There has probably never been a time when institutions of higher learning received such undivided allegiance... and... support as did the universities of Europe in the century preceding the Black Death... It brought about, in the main, a marked decline immediately after its occurrence or within the two succeeding decades... A beneficial result was the effort to counteract the consequences of the pestilence, and of other destructive forces, by the foundation of additional colleges and universities and by the extension of university privileges... Further effects or possible effects, were the growth of student rights, university participation in political affairs, changes in secondary education, and increasing use of vernacular languages in the field of learning."

Judicious and well planned annotations embellish Professor CAMPBELL's text, and an accurate and useful bibliography is appended. One important item might be added : SONOMA COOPER, " The Medical School

of Montpellier in the Fourteenth Century," *Ann. Med. Hist.*, n.s., 2 : 164-195, 1930. There is a good index. A brief summary of the author's conclusions might have added to the attractiveness of this valuable survey.

C. D. LEAKE.

(Johann Kepler, 1571-1630). — *A Tercentenary Commemoration of His Life and Work.* A series of papers prepared under the auspices of The History of Science Society, in collaboration with The American Association for the Advancement of Science (Sections A, D, and L). Pp. 133 + XII. Baltimore, The WILLIAMS and WILKINS Company, 1931. ($ 2.50).

This book contains the three addresses delivered on December 31, 1930 at the Cleveland meeting of the American Association for the Advancement of Science by W. CARL RUFUS, D. J. STRUIK and E. H. JOHNSON. A short preface and a bibliography of KEPLER's works, both by F. E. BRASCH, and a portion of a speech by Sir ARTHUR S. EDDINGTON, are also included in this volume.

KEPLER was one of those giants on whose shoulders NEWTON stood. The tercentenary of KEPLER's death was a good opportunity to review his work in the light of our present knowledge of the universe.

In the introduction Sir EDDINGTON states that " it is not too fanciful to regard KEPLER as in a particular degree the forerunner of the modern theoretical physicist... It is only in the latest years that we have gone back to something like KEPLER's outlook, so that the music of the spheres is no longer drowned by the roar of machinery." The remarkable developments of modern physics built on conceptions impossible to visualize appears to a modern mind just as abstruse and remote from reality as KEPLER's research must have appeared to his contemporaries. KEPLER was primarily a mathematician. For him the harmony of the world existed beyond any doubt. His own task was to discover this harmony.

The first essay is by Dr. W. CARL RUFUS, Assistant Professor of Astronomy in the University of Michigan, on " KEPLER as an Astronomer". The second essay, on " KEPLER as a Mathematician", is written by Dr. D. J. STRUIK of the Massachusetts Institute of Technology, and the third, on " KEPLER and Mysticism", by Dr. E. H. JOHNSON of Kenyon College. A symposium written by a number of contributors is usually heterogeneous. However, all our writers agree in deprecating KEPLER's mysticism. According to Dr. RUFUS' somewhat ambiguous simile, " The sides of a triangle may be disjoined only by wrecking the whole. Mathematics formed the base of his work, astronomy its altitude and

mysticism its slant height. At times his mystic slant carried him to dangerous ecstatic heights toward which his astronomy fain would follow, but his loyalty to mathematics applied to measured data brought him eventually to solid ground " (p. 2). Dr. STRUIK puts forward a questionable thesis that " Discoveries are never independent of the organization of society, its ideas, its conflicts, its resources " (p. 39). Dr. JOHNSON believes " that only a charitable attitude will enable us to reach an honest evaluation of the place of mystical ideas in the mind of a man like JOHANN KEPLER " (p. 58).

Nevertheless, the fact remains that most of what KEPLER wrote should be classified as mystical nonsense. The eight volumes of FRISCH's edition of KEPLER's works could be easily expurgated to make a small volume of KEPLER's *real* contribution to astronomy and mathematics. Shall we neglect all the rest as of no value whatsoever? For an historian of science the vagaries of great men are (or ought to be) just as valuable as their contributions classified as great. NEWTON's theological efforts have been explained by the hypothesis of insanity, although NEWTON himself warned us against superfluous hypotheses. Among orthodox physicists Sir OLIVER LODGE is a byword on account of his spiritualistic writings. Nevertheless, to understand NEWTON and LODGE fully we cannot neglect that portion of their work which is considered now as of no value from the standpoint of science.

The consideration of the mystical side of human nature is even more important in the case of KEPLER. As Sir EDDINGTON says, KEPLER's outlook was very much like that of a modern theoretical physicist. For KEPLER the universe was built by God on a rational plan which can be fully understood by the human mind. The number of planets was six because there are only five regular solids which can be inscribed into their orbits. Compare with this the dogmatic assertion of some modern physicists that the number of chemical elements must be ninety-two and no more, because No. 93 would be extremely unstable according to the current atomic theory.

The idea that everything in the universe is bound by a chain of causality is the fundamental assumption both of astrology and of astronomy. The difference between the two lies in the interpretation of causality. Modern astronomers smile or feel indignant, according to their temperament, at the newspaper horoscopes, but are very anxious to establish correlations between solar activity and terrestrial phenomena. KEPLER no doubt was a sincere believer in astrology, although he despised astrological quacks who understood very little in astrology and nothing in astronomy. For a man who believed that nothing in the universe was created in vain and everything had its purpose, this could not be otherwise. The often

quoted passage from KEPLER that " Nature, which has conferred upon every animal the means of subsistence, has given astrology as an adjunct and ally to astronomy", does not prove that he did not believe in astrology. His writings are full of astrological interpretations, which sometimes, as in the case of comets, were blended in a remarkable way with sound physical observations. KEPLER's work " De fundamentis astrologiae certioribus " is alone sufficient to prove his belief in what we might call " higher astrology". This aspect of KEPLER's work is ably discussed by RUFUS (pp. 35-38) and JOHNSON (pp. 69-76).

The authors did not do justice to KEPLER's equation of the elliptic motion. Under this term is generally understood the equation

$$M = E - e \sin E$$

where M is the mean anomaly, E is the eccentric anomaly, and e is the eccentricity. Dr. RUFUS (p. 21) gives two equations from which the above equation can be derived, but by oversight calls the quantity v occuring in these equations the mean anomaly, whereas it is the true anomaly.

Dr. STRUIK (p. 49) gives as KEPLER's equation

$$x = e \sin x + M$$

in which he calls M a constant. M is really the independent variable and x $(= E)$ is a function of M. The problem is to find E when M and e are known. Dr. STRUIK says nothing about the remarkable history of this problem. A selected bibliography on KEPLER's equation is given in the *Bulletin Astronomique*, 17, 37, 1900. It includes 123 items. Many great mathematicians, including NEWTON, EULER, LAGRANGE, LAPLACE, and GAUSS, contributed to the solution of this problem. One of the most remarkable solutions was given by BESSEL, and this marked the introduction of the Besselian functions into calculus.

Several unimportant inaccuracies and errors have been noticed. On the whole the book is remarkably free from errors and misprints. In Dr. JOHNSON's article many authorities are quoted in the footnotes, except KEPLER himself, even when excerpts from KEPLER's works are given. This procedure is rather dangerous while discussing such subtle subjects as KEPLER's mysticism.

The bibliography on KEPLER, by F. E. BRASCH of the Library of Congress, does not claim to be complete. It does not include the two most important contributions to the study of KEPLER : *Johannes Kepler in seinen Briefen* (ed. by M. CASPAR and VON DYCK) and *Kepler-Festschrift* (ed. by K. STÖCKL). Both were published recently (1930), but probably in time to be included in the bibliography. One of the most remarkable interpretations of KEPLER by E. A. BURTT (in his *Metaphysical Foundations of Modern Physical Science*, 1925) also has not been mentioned

in the bibliography. The Library of Congress' simplification of the German orthography by printing all the nouns without capitals is very irritating to a person familiar with the German language and might well have been avoided in the present volume.

The book is well printed and bound. It is recommended to all students of the history of science and it may serve as a good introduction to the study of KEPLER.

Perkins Observatory N. T. BOBROVNIKOFF.
Delaware, Ohio.

Gustav Eckstein. — *Noguchi.* HARPER & Brothers, New York and London. XII + 419 pp., 8 pls. 1931. Price $ 5.00.

There is much evidence that the maternal genes of industry and unconquerable devotion from his peasant mother dominated the life of NOGUCHI with perhaps a touch of reckless unconcern derived from his saki-loving and inconstant father. The portrayal of this remarkable life from the days of crippled boyhood, when he fought his way to the respect of his comrades, to the days of triumph, when his career was crowned with recognition in the medical capitals of Europe, in the research institution honored by his affiliation, and among the elect of his own native land, is fittingly portrayed by Dr. ECKSTEIN of the University of Cincinnati. In the terse dramatic style, framed in the present tense, the author relates not only the history of this remarkable life, but uses his literary form, to reveal the tenseness, moodiness, vacillating activity, tremendous drive and energy, love of the game of life, intense individualism and pride, devotion to his work, and above all his scientific imagination and skill, in detecting significant trends in his work. This unique type of scientific biography seems at first almost repulsive, but as one nears the end of the book one feels that it enhances the revelation of both the man and his work.

SEISAKU NOGUCHI, later self-christened HIDEYO (world great man), was born in 1876, son of a poor peasant farmer in Okinajima, Japan. As a babe alone in the house he maims his left hand in the coals of the urori. This misfortune was his salvation. It was a disgrace he fought to overcome in youth, its later partial restoration by a skillful surgeon incited his interest in medicine and surgery, and his doubly trained right hand became internationally famous for its skill in laboratory technique. Restlessly and inefficiently he completed his medical course in a private medical school, gained admission to the Kitasato Institute for Medical Research, only to leave soon impatiently as quarantine doctor at Yokohama. He early plans a scientific career with German and American training, and in 1901 begins work as an assistant in the University of

Pennsylvania under the direction of Dr. SIMON FLEXNER on snake venoms under the patronage of Dr. S. WEIR MITCHELL. In 1904 he spent a year at the Serum Institute in Copenhagen with Dr. MADSEN and then returned to the United States as assistant in the newly organized Rockefeller Institute for Medical Research in New York with Dr. FLEXNER as director. In 1904 SCHAUDINN and HOFFMANN discovered the germ of syphilis, *Spirochaeta pallida*. NOGUCHI, who from the beginning of his scientific career had been interested in the spiral organisms, early turned his attention to this important species and in 1910 announced his perfection of a method for the pure culture of this pathogenic form of widest medical and human interest and the cause of paresis and locomotor ataxia. There followed his world-renowned volume on the serum diagnosis of syphilis, his invitation to European medical congresses with accompanying high honors there and from his native land. In 1916 he began his study of Rocky Mountain spotted fever and infectious jaundice. The last-named disease naturally led him to the study of the seemingly closely related yellow fever of the American tropics. This resulted in expeditions into Ecuador, Mexico, Peru, and Brazil to investigate this dread disease experimentally and to perfect and test serums for its treatment. NOGUCHI was able to demonstrate the occurrence of a peculiar spirochaete, *Leptospira icteroides*, in human cases of yellow fever, to isolate the organism, and to prepare a serum against the disease. This serum, given to Andean soldiers smitten with yellow fever in the low-lands of Ecuador, gave results which were interpreted by NOGUCHI as confirmatory of the accuracy of his findings of the causative organism of yellow fever. It undoubtedly had affinities with the spirochaete of infectious jaundice and there followed a period of criticism by AGRAMONTE of Havana, Cuba, and by others familiar with the epidemiology of yellow fever. Possibilities of error, of mixed infections of the two diseases, and the question as to whether or not American and West African yellow fever were the same or distinct diseases, were suggested. Our biographer's discussion is such as to raise suspicion in the reader's mind that NOGUCHI himself was disturbed by the scientific tenor of these criticisms. Apparently in this hesitant state of mind he went to Accra, West Africa, in 1927, to study the epidemic there in the light of his results in the American tropics. Here he plunged into the work with the wealth of material, hundreds of experimental animals, experiment piled upon experiment, case after case investigated, but the elusive spirochaete evades him, and he is convinced that African yellow fever is not the disease he dealt with in South America. But his energy never relaxes in his feverish search until " At Accra, Midday, Monday", " one more has worked and perished gallantly".

NOGUCHI's interest was incited, while he was in Peru, in two Peruvian diseases, mysteriously interrelated, known respectively as Oroya fever and verruga. He was able to prove by experimental work with animals that the organism of the two was the same and that in reality they were two phases of the same infection. Whether or not recent developments in bacteriology due to KENDALL's discoveries of the supposed filterable phases of bacteria will or will not throw light on the enigma of the dramatic end of NOGUCHI, only the future will disclose.

CHARLES A. KOFOID.

S. D. Wingate. — *The Mediaeval Latin Versions of the Aristotelian Scientific Corpus*, with special reference to the biological works. The Courier Press, London. 136 pp. 1931. Price 10/6 net.

This is a doctor's thesis prepared under the direction of Dr. CHARLES SINGER. Its basis is an examination of manuscripts in thirty-eight libraries in Spain and Portugal, twenty-seven in Italy, and many in France and England. A list of one hundred and fifty-three works consulted suggests the scope of the sources. The abundant and detailed critical notes and extensive quotations from original documents indicate the thoroughness of the inquiry. The documentation exhibits methods of precision and lends value to the book as a work of reference for Aristotelian scholars of the future.

The investigation was directed primarily to the scientific works of ARISTOTLE and especially to his biological treatises, and is restricted to the genuine rather than the pseudo-Aristotelian works, although the *Physiognomia* and *De Plantis* were investigated, since they undoubtedly involve peripatetic doctrines. In fact, the alleged existence of a Latin edition of this work was the starting point of the investigation which leads to the conclusion that whether or not AVERROES composed a commentary on *De Plantis*, no Latin version of such a work is now extant. Allusions to it in manuscripts appear to be due to confusion of names or to misunderstanding on the part of the copyist.

This work provides an account of the rediscovery by the Latins of the Aristotelian scientific works in the original, and especially of those dealing with biology, during the scientific renaissance of the twelfth and thirteenth centuries.

The translation of these works from the Arabic, and especially from the Greek, by scholars who travelled to Spain or South Italy to acquire the treasures of Arabian or Greek learning, forms one of the most significant and neglected chapters in the history of thought. No comprehensive work has appeared on the subject for a century, and the literature dealing

with it is buried in a vast mass of periodical publications, monographs and general histories of philosophy.

Special attention has been devoted to the transmission into Latin of the Aristotelian biology. There are also chapters on the position of the Aristotelian corpus in the Arabian and Byzantine cultures, and on some of the more prominent versions produced at the period of the revival of learning in the fifteenth and sixteenth centuries.

C. A. KOFOID.

J. Millàs Vallicrosa. — *Assaig d'Història de les Idees Físiques i Matemàtiques a la Catalunya Medieval*, Vol. I. Etudis Universitaris Catalans, Sèrie Monogràfica I, Barcelona, 1931.

Some misgivings have been expressed recently as to the multiplication of modern languages involved in the recrudescence of small nationalities as likely to increase the difficulties of the student in following the literature of his field of interest. This volume in Catalan, however, dissipates rather than corroborates this fear, because its author shows wide familiarity with recent writings on the history of science in other languages. He is, for example, acquainted with the works in English of SARTON, HASKINS, KARPINSKI and others. A few works, however, are not cited which it would seem might have something germane to the author's investigations, such as that of A. KINGSLEY PORTER on pilgrim roads and those of BÉDIER.

This first volume of a history of physical and mathematical ideas in medieval Catalonia, extends through the twelfth century and is divided into nine chapters, of which the first deals with the Visigothic and Carolingian period, from the sixth to the ninth century, and the remaining chapters with the period of re-conquest. Of these the first two are devoted to Moslem culture and the last six to Christian culture. Then follow many pages of appendices reproducing Latin texts and twenty plates from various manuscripts. The volume concludes with indices of proper names and of technical words and phrases. The author finds that Moslem culture took little hold in Catalonia, although he devotes considerable space to the Arabic treatises on the astrolabe. Especial attention is given to the scientific activity of GERBERT and to the *Scriptorium* of the monastery of Ripoll. The work is based upon a study of various important manuscripts as well as on the latest researches of other scholars and may be welcomed as the fullest treatment we have of the field which it covers. There are abundant footnotes and references and generous extracts from the scientific writings of the period. The work has been handsomely printed by the Institució Patxot. Misprints seem to be very few. In the middle of page 248 " leonem " apparently should be " leone." It is to be hoped that the second volume continuing

the investigation into the subsequent medieval period may appear in due season.

LYNN THORNDIKE.

Harold T. Davis. — *Philosophy and modern Science.* XIV + 335 p., 9 fig., Bloomington, Indiana, The Principia Press, 1931 ($ 3.50).

In *Philosophy and Modern Science*, Prof. DAVIS has accomplished that difficult aim of so many modern scientific writers—he has written a book intelligible to the layman and valuable to the scientist. For his text, almost free of formulae and equations, presupposes no technical knowledge on the part of the reader, while it gives to those who have this technical knowledge a review of past and current beliefs replete with quotations and references. In other words it is a source book as well as a history.

One of the texts most frequently quoted is *Alice's Adventures in Wonderland*. This was said by EDDINGTON to be one of the first treatises on relativity, another being *Gulliver's Travels*. If any further evidence of the diversity of sources is needed, the reader may open the index at random—and find, for instance, COLERIDGE, COLUMBUS, and COMPTON.

The author states that his aim is to give insight into the new philosophy of nature and the metaphysics of modern science. This he seeks to accomplish by a history of the development of our concepts, philosophical and experimental, and by a description of modern scientific experiment and thought. Modern scientific history, he says, begins with KEPLER and GALILEO, but the Ancients are also frequently met in his pages. Many fundamental questions are raised ; not all are answered. The struggle between the continuists and the atomists, the ether, the problem of the finiteness of nature, gravitation,—they all receive just emphasis.

No one at present can avoid the duality of nature in wave and corpuscular theory, and Prof. DAVIS can only present the problem. The disposition of the ether also rests upon the outcome of modern experiment and theory. The MICHELSON-MORLEY experiment, while it did not yield the expected value, did obtain a positive result, later verified by MILLER—but only to the confusion of thought. Prof. DAVIS remarks

" ... These theories (of the ether) excepting that of MENDELÉEFF, have been subjected to the searching scrutiny of calculation and laboratory data. From them, one by one, their material properties have been gradually removed until but a shadow connects them with sensuous experience. The ether of LORENTZ preserves its existence as an imperative of human reason, which demands that something must exist for the conveyance of energy from place to place and for the possibility of conceiving lines and tubes of force ...

Are we seeing mysteries where there are none? I think not. The problem may be resolved, perhaps, by assuming a new definition of reality. Is it necessary

for a physical entity, in order to have reality, to be sensuous or even to have an analogy with material things? If we are willing to answer this question in the negative, then we have committed ourselves to what may be regarded as a metaphysical philosophy."

The question of finite bounds to nature the author answers by pointing to the lower limit to temperature and the upper limit to velocity, as well as to the finite space of the modern universe. Gravitation is no longer the action at a distance of NEWTON, but the warping of space-time of EINSTEIN:

"And what are our conclusions about the mysterious action at a distance?... We have traced its history from the laws of KEPLER, through the magnificent postulates of NEWTON, to the new revelation of EINSTEIN. We have seen it start with the metaphysical assumption that objects are influenced by a force which acts through the vacuum of space; we have reviewed its struggle to gain objective reality by the postulate of an etherial fluid composed of rapidly moving "ultramundane corpuscles;" we have traced the attempts of careful experimenters to discover some objective characteristic of gravitation other than that of attraction; we have finally witnessed the overwhelming of these objective pictures in the subjective equations of EINSTEIN, in which space-time becomes the reality. Here at last we are able to gain new experimental evidence where all previous efforts had been in vain."

A book of such scope can never be perfect; one can always find flaws, though Prof. DAVIS has kept them down to a comparatively small number. Some are mere slips, such as the reference to the "double protoned nucleus" of helium; others occur through failure to grasp thoroughly the changes of thought, or through oversight. It is a pity that the report of the recent symposium on the structure of the universe did not appear before Prof. DAVIS's book, for his discussion of the static universe of EINSTEIN, the empty universe of DE SITTER, and especially the expanding universe of LE MAÎTRE could be improved with little trouble. Moreover his treatment of the second law of thermodynamics in the macrocosmos and of the origin of cosmic rays is a discussion of MILLIKAN's views only and neglects the loudly dissenting voice of JEANS. It is, to be sure, a pessimistic voice, with its insistence on the heat death and its appropriation of the energy of radiation to expand the universe. Other statements are not quite correct, and many are open to argument; for instance, SHAPLEY's terms "metagalaxy" and "supergalaxy" are confused; "rationality," as Prof. DAVIS uses it, has not necessarily the meaning it has for others.

On the other hand, there are many pleasing sentences, such as: "Ideas are not the product of individuals but rather the product of movements, to which each individual has added an increment of thought."

In short, *Philosophy and Modern Science* is "good reading," and the imperfections which have been mentioned are but a small part of it. It seemed to the reviewer to be decidedly worth reading, and its value is enhanced by its appearance at a time when so much attention is being paid to scientific technicalities little understood by the avarage man.

The volume is attractively bound and printed by the Principia Press, and is unusually free from typographical errors.

Harvard College Observatory. CAROL JANE ANGER.

Ernst Almquist. — *Grosse Biologen.* Eine Geschichte der Biologie und ihrer Erforscher. J. F. LEHMANNS Verlag, München. 143 pp., 23 portraits. 1931. Price M. 8.00 geb.

This is not a general history of biology, as the subtitle might seem to indicate. The author is interested in the persistence of species and in the occurrence of races or small species within specific limits as usually defined in most systematic treatises. This accounts for his emphasis on the *status praesens* of organisms, his full presentation of ALEXIS JORDAN's researches upon the small species of *Viola* and of *Draba*, in both of which genera, as well as in *Capsella*, notable instances of numerous, stable small species occur within the limits of the common, well-known species. The author's own results lead him to postulate the origin of new species by the crossing of northern and southern species since the ice age. The transformist ideas of LAMARCK and his followers are scarcely more than mentioned in this history of biology, and the rich and significant findings of American and other palaeontologists are entirely omitted.

Our author relates in detail LINNÉ's experiments in hybridization, and states that they were the first to be made for scientific purposes. He also summarizes the Swedish botanist's experiments with the sexual processes in plants, with the relation of pollen to seed production, and the agency of wind and of insects in fertilization. His conclusion that fertile hybrids rested upon close relationship of the parents probably did much to inhibit experimentation till MENDEL's results were rediscovered at the opening of the present century.

ALMQUIST's strong predilection for fixity, or at least for persistence of species, and his emphasis on the efficacy of hybridization in establishing new stable forms leads him to drag in, as it were by the heels, Count ARTHUR GOBINEAU, the French diplomatist and embittered opponent of democratic movements. It was he who proclaimed the dysgenic effects of the Parisian guillotine.

The treatise includes twenty-three among the great in biology. Not many biologists would have included more than half of them. The Germans selected are MENDEL, SCHLEIDEN, SCHWANN, ARTHUR MEYER,

VIRCHOW, DE BARY, SCHWENDENER, BREFELD, KOCH, VON BAER, and NÄGELI; the French are represented by PASTEUR, JORDAN and GOBINEAU; the English by HARVEY, DARWIN, F. BACON, and J. S. MILL ; the Scandinavians by LINNÉ and HANSEN ; the Greeks, Dutch, and Americans by ARISTOTLE, DE VRIES, and THEOBALD SMITH, respectively. The treatment is primarily based on the significance of the contributions of the men, with respect to the opening of new fields either by new methods or by new applications. This procedure is modified as above suggested by the author's own theoretical point of view.

CHARLES A. KOFOID.

Casey A. Wood. — An introduction to the literature of vertebrate zoology, based chiefly on the titles in the Blacker Library of Zoology, the Emma Shearer Wood Library of Ornithology, the Bibliotheca Osleriana, and other libraries of McGill University, Montreal, Canada. Compiled and edited by CASEY A. WOOD. XIX + 643 p., frontispiece. Oxford, University Press, 1931 ($ 15.00).

This extensive bibliography and historical treatise on the literature of vertebrate zoology is based on collections of the literature pertinent to this subject of sufficient extent to make this volume invaluable to students and investigators in this field. It constitutes also a very convenient work of reference for the bibliographer and librarian. It consists of three sections. The first part consists of introductory matter which furnishes a brief account of the literature of vertebrate zoology from the earliest times to the present from the writings of ancient and medieval zoologists, ARITOTLE, PLINY, DIOSCORIDES, AVERROËS, to the more important treatises and monographs on ornithology, mammalogy, ichthyology, and herpetology of the twentieth century. Included are general treatises and numerous periodicals and serials, monographs on vertebrate palaeontology, zoogeography, ecology, psychology, bionomics, experimental zoology, etc., likely to interest the advanced student and the librarian.

Brief descriptions are also given of Natural History Societies, Museums, and Zoological Stations throughout the world ; travelogues of naturalists ; drawings of animal painters and illustrators, more than 5000 originals of which are in the McGill libraries.

The annotations in this catalogue often indicate the extent of the contents which refer to birds, or to vertebrates, describe the general character of the work, or pass judgment upon its value or significance. The entries fill 644 pages and number about 20,000. Articles in journals are not included, unless available as author's editions. The bibliographic form used is excellent, except for the facts that the publisher has been omitted, as a rule, and that the paginations are not always given.

OCT 15 1932

The introductory 146 pages constitute an historical and bibliographic review of the literature of vertebrate zoology with brief biographical notes upon the life and work of many of the authors, accompanied by citations of their main contributions.

C. A. KOFOID.

Maximilian Rudwin. — *The Devil in Legend and Literature*, XIV + 354 p. The Open Court Publishing Company, Chicago, 1931.

Although this volume may be of some interest from the literary and legendary standpoints, it has no value for the history of science. The author is wholly unacquainted with various discussions of the nature of demons by learned medieval writers, whether theologians or physicians. He does not correctly set forth the explanation of *incubi* and *succubi*. Even a classical authority on demons such as APULEIUS is mentioned only as one said to have made a compact with the devil. The author is, indeed, unacquainted with the middle ages in general, which he characterizes as " that dark period of human history " (page 224). He makes such wild and absurd assertions as the three following, all of which occur on the same page (249) : " For this reason, all wordly learning was taboo to the theologians " ; " Catholicism has considered philosophical speculation the work of Satan " ; " All inquiry into the mysteries of nature was regarded by the Church as black magic." RUDWIN fails to make any use either of HANSEN's *Zauberwahn, Inquisition und Hexenprozess im Mittelalter* (1900) and *Quellen und Untersuchungen zur Geschichte des Hexenwahns* (1901) or of my *History of Magic and Experimental Science*. The work seems to belong in the same class as those of MONTAGUE SUMMERS.

LYNN THORNDIKE.